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Engineering News-Record

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Maintenance Data on Twenty-Eight Sections of Test Road

Solving Construction Problems in Canal Street Subway
By A. J. MAYELL.

Grit Chamber and Fine Screens for Part of New York Sewage
By CHARLES E. GREGORY.

With the Divisional Engineers in a Great Offensive
By CAPTAIN CHARLES E. DeLEUW

Relieving Arches in Street Under-crossing Distribute Stress

American Engineers Kidnaped by Chinese Bandits

April 3, 1919

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Volume 82 April 3, 1919 Number 14

Engineering News-Record

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CHARLES WHITING BAKER, *Consulting Editor*

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Published Weekly. Entered as second-class matter Apr. 11, 1917, at the Post Office at New York, under the act of Mar. 3, 1879.

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A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN, *Editor* — CHARLES WHITING BAKER, *Consulting Editor*

Volume 82 — NEW YORK, THURSDAY, APRIL 3, 1919 — Number 14

Real Military Engineers Were Needed at the Front

MOST of the engineers in the great war found service somewhere behind the lines. The proportion so engaged, which has been variously estimated up to as high as 95%, reached all the way from the immediate Service of Supply in France back to the ports in this country and to the camps and factories which contributed the men and material for the fighting front. So large was this proportion and so important was the work they did, that the more spectacular services of the fighting engineers have been lost sight of in the current engineering stories of the war. But no American engineer should forget that throughout the months that we were in action, up under fire of the German guns there were always thousands of brave, indomitable, resourceful men, with the castle of their corps on their collars, pushing forward with and at times ahead of the infantry spearhead which broke the German line. This was military engineering pure and simple. All else that the engineer did was civilian engineering necessary to the conduct of a war. It required little of military intelligence, little of military experience. The divisional engineers, a glimpse of whose work Captain De Leuw gives in his article on another page, were the real fighting engineers. Their work, or at least the direction of their work, requires military-engineering training. The men who carry it out must be, above all, soldiers, and the major part of their experience certainly should be that of a soldier.

Morale as a Disregarded Asset

A FURTHER blow has been given to the strength of the engineering organization engaged in subway construction in New York City. The city authorities delayed until Mar. 28, three days before the end of the quarter, the money appropriation necessary for continuing the engineering staff in service after Apr. 1. Last December the same proceeding was carried considerably farther; the appropriation was delayed until a month overdue, leaving the subway construction work substantially without an engineering organization for a full month. When the organization was reassembled, the damage done by the delay became quickly apparent. Some men did not return to the service. Others, perhaps most of the remainder, had had their allegiance to the commission's work profoundly shaken, and as a sequel a distinct loss of the spirit of loyal service and cooperation necessary in every great enterprise became apparent. No member of the organization knew whether his activities would continue after the last day of March. Even more after last week's performance, the commission's engineers have no certainty whatever as to the continuity of the work. The city authorities have seriously injured the morale of the organization.

Detroit Water-Filtration Experiments Fully Justified

ANOTHER experimental water-treatment plant has been justified by the light it has thrown upon the design of proposed works to treat the water-supply of a city, as shown by the brief article on page 662. A full year's tests show that the Detroit supply can be treated at a much higher unit rate than is common to mechanical filtration in the Central West. The tests also indicate that alum will be preferable to lime and sulphate of iron as a coagulant for this water. It is to be hoped that the plant will soon be put under construction. Complete treatment of the water would presumably lower the somewhat high typhoid and general death rates, besides effecting a marked improvement in the appearance of the water. The educational work done in connection with the experimental plant is commendable.

To Direct Federal-Aid Road Work

ALMOST on the day that last week's issue of *Engineering News-Record* went to press announcement was made that Thomas H. MacDonald, chief engineer of the Iowa State Highway Commission, had been appointed engineer in charge of the work under the Federal-aid road act. It will be remembered that last week's issue urged that the new director for the Bureau of Public Roads be appointed as quickly as possible. Mr. MacDonald's appointment is not as director, but as engineer in charge of the Federal-aid road work, this apparently being due to the failure of Congress to vote an adequate salary for the man who is to supervise a $200,000,000 expenditure of Federal money. Mr. MacDonald will eventually succeed to the post of director, but not, we hope, until the Congress of the United States votes a fitting salary. Mr. MacDonald goes to the job with excellent qualifications, both as to personality and experience. As chief engineer of the Iowa State Highway Commission, he has handled a good-roads project almost parallel to that, though on a smaller scale, of the Federal-aid act. In Iowa the state supervises all the county work, though the work is paid for by the counties. Obviously, the directors of such work must proceed with extraordinary tact and with full appreciation of the local problems. The points of view necessary for success in Iowa are exactly those necessary in the larger post to which Mr. MacDonald is now going. The whole highway field has confidence in him and will gladly pledge him hearty and unqualified support.

A Workable Shipping Plan

IN THE plan outlined by Chairman Edward N. Hurley of the Shipping Board for a permanent ship-operating policy and system for the United States, the first workable and well considered proposal to solve the sea transportation problem is laid before the nation. Shipping men, who might well have worked toward a solution of the problem before this, appear to have maintained an attitude which at the best was passive. Their interests, of course, are by no means simple, nor are they identical with those which Chairman Hurley represents, for the habit of foreign control has not yet passed from our shipping industry. Because little has been done toward solving the problem up to now, we must welcome a plan based on Mr. Hurley's steadfastly aggressive championship of a permanent American sea commerce. This stand, and the shrewdness he has displayed in most phases of the Shipping Board's negotiations, give great weight to his plan.

It is a workable plan, we have said. The major difficulties of the sea transportation problem are duly taken care of. Skillfully turning the flank of the seaman labor problem, the plan removes one of the two essential causes for apprehension concerning our merchant-marine future. It deals with the other difficulty, that of excessive capital account, by providing for selling vessels at the current market price, just as has been done in England. The plan suggested is practicable and until something better is presented it is bound to form our working hypothesis of ship administration.

What is important for every citizen, whether he be engineer or not, to remark concerning this plan, is that our great Government merchant fleet will largely be completed before the plan can be adopted, organized and started in operation. Our fleet of ten million or more tons will be at work, soliciting, receiving and carrying freight, before the new machinery can take hold of the service. This will mean that at all events the Government must go into ship operation temporarily, and that its operating organization must be developed and enlarged to care for the increasing duties. With such enlargement the Shipping Board will be able to carry on operations temporarily without any need for hurrying the final shaping of the plan, and at the same time its accumulating experiences may be put to use in perfecting the details of the plan. It is quite important that this condition be clearly seen, as otherwise the country may be led into hasty action with regard to the release and sale of its ships, which may start the disorganization of our merchant marine before even it is created. The great present question is to get the ships going, not how they are to be kept going.

Three phases of the shipping problem and Mr. Hurley's plan are of primary importance, in so far as they have relation to engineering work in addition to ship operation. These phases are the close parallelism between the railroad problem and the shipping problem; the question of foreign terminals; and the question of future shipbuilding.

Precisely the same mixture of public service and private interests is found in our shipping as in our railroad problem—provided we take the same public-interest stand as Mr. Hurley, who frankly bases his argument and his plan on the overshadowing importance of developing the shipping industry for the greatest good of the country. There are, moreover, precisely identical difficulties in the two cases. Both involve capital-account questions that seem to make it inevitable for the Government to take a loss chargeable to war cost. Both require the same adjustment between hitherto customary rates and a higher wage level. Both present the triple question of Government operation or Government control or uncontrolled private operation. Despite many surface dissimilarities, the two subjects, railroad and shipping, become more closely similar the more fully the case is studied.

That Mr. Hurley has provided in his plan for intimate coöperation of Government and private functions is of extreme interest in its bearing on the best solution of the railroad problem. He avoids Government ownership, but instead counts on turning every piece of property over to private owners just as quickly as possible and without any restrictions. He arranges for Government financing, and virtually makes Government credit available by using the difference between Government and commercial interest rates to produce an emergency fund which shall protect the whole system in its operation and equalize individual losses. He arranges for control with respect to essential public interests, so that, for example, ship routes shall be established as our commerce needs them; but beyond this he leaves the business wholly free from regulation. Finally, he arranges for covering certain losses by the emergency fund to be drawn from excess interest payments on the purchase mortgages and from excess of private over Government insurance rates.

In emphatic advocacy of our present seamen's protective laws and in a refutation of the oft-made claim that they put American shipping at a tremendous disadvantage, Mr. Hurley, in his report on his European trip, rendered just before the publication of his plan, has exhibited a resolute determination to take account of the irresistible world drift toward stabilized labor conditions. He shows that the storm which has raged about this subject for quite a time past has not shaken him. At the same time, however, it is evident that his plan, though it makes no express provision for any unbalanced labor cost which might render American operators unable to compete, does, in fact, allow for this difficulty. Through the power of the administrative board and its emergency fund of many millions of dollars, the object can be attained. There is no such word as subsidy in the plan.

It is instructive in relation to the railroad problem to observe how Mr. Hurley avoids not only Government ownership or operation—he asserts that he means in his plan to secure the benefits of private enterprise—but also avoids the public-private corporation, a device much discussed with regard to the railroad problem, but one whose dangers we do not yet know. By avoiding these two evils, as well as that of wholly uncontrolled private operations, he offers a system well worth the attention of those who are formulating or are considering railroad operating plans. Perhaps it may even turn out that the finally successful railroad and shipping plans will both be devised as the result of joint study of the two problems.

As to terminals, it is necessary to observe that no provision whatever has been made by Mr. Hurley for ship terminals abroad. This is a defect, it would seem. He says that he desires to give the small ship operator a chance, since only thus can the industry be developed to size and strength. Yet if the small ship operator is to be put in position to make a fight for business

and hold it, he must in many parts of the world be aided in securing port and terminal facilities. It may be that terminals are a detail which will develop in the working out of the plan. We prefer, however, to regard it as a major question. Involved as it is with the subject of international relations, machinery additional to that which Mr. Hurley has conceived will be needed to take care of it. The need for this machinery may be short-lived, since ultimately the question of terminals should adjust itself; but during this temporary period we conceive that terminals will be vital in the development of our foreign shipping business.

Shipbuilding, finally, is a matter to which Mr. Hurley's plan gives no attention, and the shipyard man is left without encouragement or prospect as to anything beyond the current year. Stability in shipbuilding is closely inter-related with stability in shipping. So far we remain in the stagnation of thought which the Shipping Board created last fall. A plan for future shipbuilding is as important a need as a plan for ship operation, and the two should probably be combined. Full shipyard efficiency can be brought about and maintained only by reasonable assurances concerning the future.

Food for Thought in a New York Engineers' Meeting

LAST week's meeting in New York to discuss the engineer as a citizen offered food for thought, not so much in what was said by the speakers designated to open the discussion as in the thoughts offered in discussion and the ideas to which they naturally give birth. A movement was started to organize a New York local engineering society. There was some plain talk, such as is seldom heard in what the chairman called the "temple of engineering," while it remained for the floor discussion to face clearly the engineer's responsibility as to the most pressing questions in our social unrest. A brief account of the meeting will be found in the news section of this issue.

First, it may be said that there should be no delay in bringing to an early conclusion the purport of the resolution to establish a New York local engineering society. With all our talk about the engineer standing up and having his say on civic matters of an engineering character, the engineers of the country's largest city have remained unorganized and inarticulate. In stringent cases the central administrations of the national societies have bestirred themselves, but they have acted out of their natural sphere when they did so. Moreover, with their primary function one of national service, it is futile to expect them to follow closely and act on all manner of local questions.

As to the opening discussions at the meeting, none of them brought out in any adequate way the chief opportunity and the chief responsibility of the engineer in our present era of dominant industrialism, nor took up and handled conclusively the labor sore spots in our present crisis. Several of the speakers called upon the engineers to withstand the wave of Bolshevism should it break on our shores, but none of them analyzed the cause of Bolshevism nor pointed out the industrial measures that can cure the disease. It remained for one of the audience, Lieutenant Van Gilder, to point out the need for impartial study of this phase of the question.

The responsibility is so obvious that it is all the more remarkable that the subject was not handled fully and convincingly. The present industrial order is the creation of engineering. It is a mechanism by which labor is directed more or less intelligently and efficiently in the creation of things that satisfy human wants. In our conception of industrial economics we recognize two main elements—materials and labor. As to the first, we have left and are leaving nothing undone within the limits of human knowledge to determine all factors that affect their efficient use. In fact, we are constantly pushing out the bounds of human knowledge, by research work, that we may still further increase efficiency in the use of materials.

As to the other factor, labor, we have done relatively little. Taylor, and those who have followed him, have been building up a science of management, but relatively few competent men are engaged in the task. Furthermore, all but two or three set narrow limits to their inquiry and are interested in the efficiency of the worker only while actually at his task or machine. Yet back of that is a host of factors—human factors—that condition his efficiency. These factors—health, housing, the stimuli of sustained interest, the share in the value of what is produced, etc.—all need to be attacked with the clearness of the engineer's vision. They are being attacked, but by long-haired reformers, by rabid leaders, and the results have been far from wholly good.

Scientific principles and mathematical formulæ now in existence may be of no avail for instant application to these human problems, but the elements can be clarified by the impartial examination that is fundamental in engineering inquiries.

Of the plain talking, the most interesting was Mr. Johnson's sharp criticism of the type of men elected to office in our national engineering societies. He described them as men who had won reputations and were afraid of damaging them by starting something new. His analysis may be partly true, but in the general import of his remark—that we elect men to office rather to honor them than to secure for the society services that will really be of value—we heartily concur. "Young men for war, old men for council." The conduct of a worth-while society requires both types. Action is needed, but action tempered by experience. Now, however, the experience is dominant; there is so much counsel that action is inhibited. In business we put the older men in the directorate, but the department heads, who get action, who originate new ideas and methods, are young men. In societies the secretary must be of the action type or have active men under him, and in the board he needs supporters of the active type as well as counsellors of conservatism. Above all, there is needed, every other term, a president selected for the service he is able to render the society rather than for the honor which the society can confer on him.

Mr. Johnson's views are good food for thought for nominating committees.

Finally, a remarkable thing about the make-up of the audience was that it was composed three-fourths of the distinctly younger men. Gray heads and bald heads were in the minority—an indication that the generation coming into power will concern itself more with the engineer's responsibility as a citizen than did the past.

Solving Construction Problems in Canal Street Subway

High Ground-Water Level Complicated Deep Construction Work Under the Old Subway in New York City — Pit and Drift Methods Used

By A. J. Mayell
Assistant Division Engineer, Public Service Commission, New York City

UNUSUAL methods were adopted in the solution of several problems which developed during the construction of the short section of the Canal St. subway in New York City, between Broadway and the Bowery. The primary cause of the adoption of these unusual methods lay in the difficulties due to the high ground-water level, and led to the process adopted, which consisted essentially in digging square pits as deep as the ground-water level would permit, lowering the ground-water level, excavating the cut, extending the pits to lower levels, and concreting them. Under the Centre St. loop, drifts were used in three levels, provision being made to set forms for wall and skew back of the roof arch as the drifts were widened out in 8-ft. sections. Considerable leakage developed at the points where overhead lap joints were made in the waterproofing. This has been reduced by forcing grout under pressure through holes drilled in the concrete.

The street surface of Canal St., from Broadway to Centre St., is only from 10 to 12 ft. above mean high water, and the normal level of ground water is only slightly below mean high water. The first problem involved the lowering of ground water sufficiently to permit building the structure. While normal ground water was only slightly below mean high water, as stated, pumping in the vicinity, by other contractors, had lowered the ground-water level about 15 ft. before the construction of the Canal St. crosstown line, known as Sec. 2, Route 20, was started. The lowering of the water from elevation —15 to —35 was accomplished by continuous pumping from three sumps and two well-points with 3-, 5- and 8-in. centrifugal pumps.

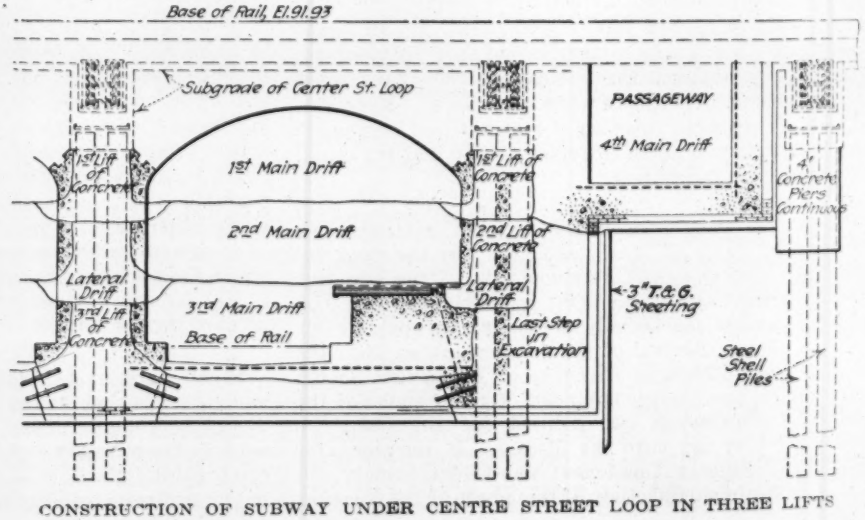
Protection of the buildings along Canal St. from damage due to settlement was accomplished in an unusual manner. Instead of underpinning the buildings, the contractor protected them by means of a continuous concrete wall constructed by the "pit" method, which may be briefly described as follows:

Attacking the work from three shafts, one just east of Broadway, one between Lafayette St. and Centre St., and one at Harry Howard Square, the contractor removed the top lift of the excavation to a depth of about 10 ft. for the full width of the cut. Pits 4 ft. square, spaced 4, 8 or 12 ft. apart were then excavated on the neat lines to such depth as ground water would permit, and filled with concrete. Intermediate pits were then excavated and concreted, until the piers formed a continuous concrete wall 4 ft. thick along each neat line. The needles across the cut supporting the timbering, pipes and street decking either butted against or were recessed into these piers.

In the meantime, pumping from the sumps had been started, and ground water lowered enough to allow excavation to within a few feet of the bottom of the concrete wall, when the process of extending the wall to a lower level was started. This was done by undercutting the wall in 4-ft. sections and excavating these pits to such further depth as the lowered elevation of the ground water permitted. These pits were so spaced that not more than 4 ft. of the wall in every 12 ft. was undermined at one time. After the pits were concreted, the intermediate pits were excavated and concreted, and the process was repeated until the entire wall was extended to this lower level.

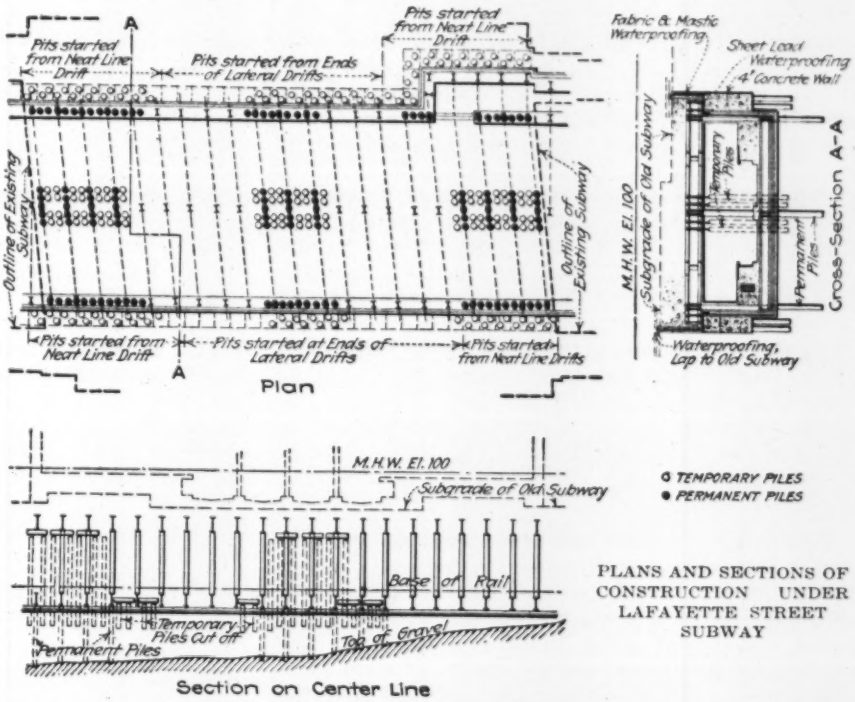
This process of lowering the ground water, excavating the cut, extending the pits to lower level, and concreting them, was repeated until the excavation was within a few feet of subgrade and the cut was protected with a continuous concrete wall on both sides. East of Centre St., where the ground water was lowered below subgrade, the wall was extended a few feet below subgrade, while west of Lafayette St., where lowering the ground water the last few feet was a slow operation and where poor soil conditions were encountered, steel sheet piling was used for the bottom four or five feet.

These concrete walls not only took the place of sheeting but also, with certain additional bracing across the cut, acted as protection for the buildings. As the contractor was entitled to unit-price payment for protecting buildings, and as most of the sand used in the concrete was taken from the cut, the cost of constructing these walls was considerably less than would have been the cost of sheeting the cut and underpinning the buildings.



CONSTRUCTION OF SUBWAY UNDER CENTRE STREET LOOP IN THREE LIFTS

Another problem was the construction of the new subway under the existing subway structures in Centre St. (Centre St. loop) and in Lafayette St. (Interborough subway). When the Centre St. subway was built in 1910-11 the loads were carried to heavy floor girders which, in turn, were supported on steel shell piles driven below the subgrade of the proposed crosstown subway, so that the construction under Centre St. was not a very difficult matter, but the method adopted was somewhat original. The plans called for concrete arch construction over the tracks, and in order to make progress, and still not wait for the ground water to be lowered to subgrade, drifts about 10 ft. deep were excavated along the center line of both tracks of the crosstown line. These drifts were widened out to expose the piles, but the material around the piles was removed in 8-ft. sections at a time.



PLANS AND SECTIONS OF CONSTRUCTION UNDER LAFAYETTE STREET SUBWAY

As each 8-ft. section was uncovered, forms were set for the wall and the skewback of the arch and this section was concreted. This method was continued until the entire center wall with the skewbacks of the arches and the portion of the 8-ft. sidewalls inclosing the piles were concreted to a depth of about 6 ft. The excavation was then deepened in 8-ft. lateral drifts, and the next lower section of the walls was concreted. The top board of the forms was inclined outward and extended above the bottom of the wall already placed so as to permit placing the concrete under a slight head. The horizontal joint between these pourings was grouted after the concrete had set and settlement and shrinkage had taken place.

USE OF 8-FOOT SECTIONS IN CONCRETE CENTER WALL UNDER CENTRE STREET LOOP

Excavation was then continued to the bottom of the wall as placed, and again lateral drifts were excavated, this time to subgrade, and the bottom protection concrete and brick-in-mastic waterproofing were placed. Then forms for the bottom section of wall were placed and concreted. The remainder of the excavation was then removed and the invert placed.

The reason for constructing the walls in 8-ft. sections was to avoid placing entire dependence for the support of the overhead structure on the piles, which would have resulted if the material around the piles had all been removed at the same time.

The method of construction under the old subway in Lafayette St. was more difficult, as no provision had been made when it was built to support it during the construction of the crosstown line. The first operation was to excavate a drift about 8 ft. wide and 8 ft. deep under the old subway along the center line of the crosstown line. This drift was carefully sheeted and braced across with timber struts top and bottom. Under the center line of the Lafayette St. subway a lateral drift was then excavated from the center drift to points about 4 ft. outside the north and south lines of the crosstown line. At the ends of this drift, pits 4 ft. square were sunk, with horizontal sheeting to the ground-water level, and concreted. Two ply of sheet-lead waterproofing were then placed over the top of the concrete piers, and protected with a layer of cement mortar.

The first roof girder was then brought in through the center line drift and placed in the lateral drift in its final location, resting on blocking on the soil, the ends being supported on the concrete piers at the ends of the drift. The roof girders were ordered in three sections so that they could be handled in the drifts, and were spliced after being placed in position.

A 4-in. wall of concrete was then placed at the ends of the drift, a strip of the protection concrete on the bottom of the old subway was removed, and three-ply waterproofing fabric mopped with coal-tar pitch was placed on the protection wall and carefully lapped onto the brick and mastic waterproofing on the bottom of the old subway. The lower end of the fabric was dovetailed with the sheet lead previously placed on top of the concrete pier. About 1½ in. from the fabric a brick wall was erected, and the pocket thus formed was filled with mastic.

Forms were then set 3 ft. each side of the girder, and concrete was placed around the girder about flush with the top of it, keys being left in the concrete and rods being placed to bond it with the adjoining concrete to be placed later. After the concrete was set, posts and caps were placed on top of the girder and wedged up to support the overhead structure.

Another lateral drift was then excavated adjacent to this, and the same operations were repeated; a third drift was excavated on the other side of the girder and this operation was continued, with drifts alternating east and west of the first. The space between the top of the girders and the bottom of the old subway was placed by hand and packed well with rammers. Grout pipes were placed longitudinally with "tees" looking up in each bay for the purpose of grouting during construction, and vertical pipes were placed in each bay for final grouting after the entire roof was placed.

Steel Shell Piles Support Roof

After several roof girders had been placed and concreted, the center line drift was deepened to permit jacking of steel shell piles to support the roof construction while the core of excavation was being removed. Four rows of 12-in. steel shell piles, two rows on each side of the center line, spaced so as to avoid interference with the center line columns and the transverse steel, were jacked in place. These piles were in sections from 5 to 7 ft. long; the material inside the piles was cleaned out as the piles were driven, additional sections being added and held in place by an interior collar. When the piles reached a depth of about 2 ft. below subgrade they were concreted and tested. Jacking was continued until the pile showed no settlement under a test load of 70 tons.

The piles were capped with short pieces of channels, and 15-in. I-beams were placed spanning from a pile on one side of a roof girder to one on the other side, and wedged up with steel plates and wedges under the bottom flange of the girder.

Drifts had in the meantime been started under the concrete wall formed by the piers at the ends of the lateral drifts. Pits 4 ft. square were excavated under the wall, and piles jacked below subgrade, similar to the piles in the center drift; the piles were concreted and tested and the pits concreted and sealed.

The remaining core of excavation was then removed to the base of the rail. On account of the poor bearing power of the soil, it was decided to have additional piles driven directly under the floor girders. Four additional piles were then jacked down to bearing on a stratum of gravel varying from 6 to 12 ft. below subgrade under each floor girder; one pile being directly under the center-line column and two on each side of the center line; under the side walls one pile was driven under each girder and two were driven between each pair of girders.

After these piles were driven the floor girders were placed and brought to bearing on the piles by means of steel plates and wedges. The temporary piles were then cut off, sealed with asphalt and capped with steel plates, and I-beams were placed on top of them between the floor girders, and posted to the roof. The floor was then waterproofed with brick and mastic, and concreted, boxes being placed around the posts on top of the I-beams. After the concrete had set the posts were removed and the boxes concreted.

The maximum settlement in the overhead structure was 2½ in. in the track columns and 3 in. in the platform columns. About a year after the structure was completed and put in operation and the ground water had returned to its normal level, considerable leakage developed in the new structure. The leakage appeared wherever an overhead lap had been made to the waterproofing of an overhead structure; namely, under the Lafayette St. subway and in certain stairways where connections had been made to the Centre St. loop station. It was thought that a slight settlement had taken place in the mastic waterproofing, and the laps had pulled away enough to permit the entrance of water underhead.

EXTENDING PITS TO LOWER LEVEL ALONG NEAT LINE OF CUT

The remedy suggested was to drill holes through the interior concrete in the direction of these laps and force a thin mixture of grout into the holes, under enough pressure to seal the openings. This method has been tried and has proved very effective, the leakage having been reduced from about 150 gal. per minute to less than 5 gal. per minute. The grouting is not yet finished, but it is believed that the leakage can be entirely stopped and the station made absolutely dry in consequence.

The Underpinning and Foundation Co., was the contractor for the construction of this section of the subway.

Effects of Insufficient "Curing" Period in Water Softener

Incrusted filter sand, limed-up meters, coated service mains and persistent troubles with hot-water heating apparatus, all in greater or less proportions, are the result of an insufficient detention period in the settling basins of the Grand Rapids, Mich., water-purification plant.

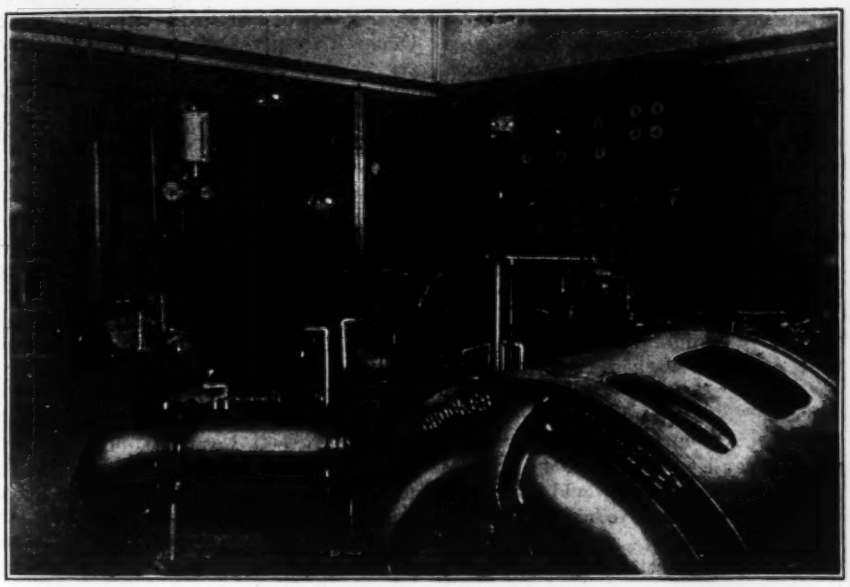
Details were given by W. A. Sperry, chemist of the filter plant, at the recent meeting of the Illinois section of the American Water-Works Association. Comparing the sand as placed in 1912 with analysis made in August, 1918, the effective size had increased from 0.27 to 1.05 mm.; the uniformity coefficient had decreased from 1.61 to 1; the thickness of coating is now 0.255 mm. Intervening increases were given in *Engineering News-Record* of May 10, 1917, p. 304, and Aug. 22, 1918, p. 358. Classifying the troubles found with the 3827 meters, out of a total of 22,000 meters, sent to the shop during the year which ended July 1, 1918, 53.9% were limed-up only; 12.1% had lime and mechanical troubles; 19.3% mechanical troubles only; 8.1% were frozen; 1.5% sand clogged; 0.2% taken out for test; 0.1% found all right, and for 4.8% there was no information.

Design of New Electric-Drive Water-Pumping Station Was Governed by Power Rate

Current Charge for Three Months Depends on Maximum Use in Any Two-Hour Period—Universal Meter System Postponed Because Temporarily Cheaper to Pump More Water, but Expected to Come Later

By Henry W. Taylor
Consulting Engineer, New York City

DEVELOPING a new pumping station for the water-works of Cohoes, N. Y., from 1914 to date, involved unusual conditions as to water consumption, change in power, power rates and changes in design. The chief controlling factor has been the rate for electric power. This has reacted on pump capacity and has caused the temporary postponement of the introduction of a universal meter system. In 1914 the water-works were in charge of a water board under the old city charter. The pumping plant consisted of three reciprocating pumps, driven by two water turbines, and one electric-drive centrifugal pump, which was used during low-water stages of the hydraulic canal. All of the equipment, except the electric-drive pump, was from 20 to 30 years old and was in a condition requiring constant repair and subject to unexpected breakdowns. Mechanically, the equipment needed replacement, in any case, on the basis of safety and economy.



THE TWO LARGER PUMPING UNITS, PRIMING OUTFIT AND SWITCHBOARD OF THE COHOES PUMPING PLANT

In 1914 the Cohoes Co. was still operating the old hydraulic canals which were serving the individual lessees of property along these canals and providing water for power. The old scheme of hydraulic canals resulted in an uneconomical use of the total water power available from the Mohawk River, and the Cohoes Co. was, in 1914, developing a scheme for the installation of a central hydro-electric generating station which would use all the water available from the Mohawk River under a maximum head and with maximum efficiency. The mill owners were to be supplied with electric power which was to supplant the water power previously provided them. Such a reorganization, affecting many different types of mills and a multitude of owners, involved a considerable amount of time, but eventually, special contracts were agreed upon which made a central power station possible. Thus the hydraulic power was eventually supplanted by electric energy.

The city pumping station represented one of the properties which had heretofore used hydraulic power, and the water board must necessarily look forward to a change in its pumping equipment for electric drive. In 1914, the question of contracts was still unsettled, but it was supposed that the best rate which could be obtained in the new arrangement would be about ¾c. per kilowatt-hour for night pumping.

The water consumption at Cohoes approximated 225 gal. per capita per day in 1914. Metering was brought to the attention of the board, but was temporarily rejected on the basis of certain peculiar conditions involved in metering the city. Without meters it was found that, at certain times during excessively cold or hot weather, the water consumption frequently ran to from 8,000,000 to 10,000,0000 gal. a day. The normal daily consumption was from 5,500,000 to 6,000,000 gal. Without meters it could not be expected that this rate of consumption would be materially decreased; while, on the other hand, provision must be made for its material increase. The further requirement that pumping must be done on a 12-hour basis to secure the advantage of the better electric-power rate necessitated a pumping station having a capacity twice that of a 24-hour plant. It was therefore decided to abandon the present pumping station and build a new station containing three 10,000,000-gal. units, consisting of centrifugal pumps with direct-connected motors and accessories.

Complete plans were drawn for such a scheme. They involved a new pump house, a new house for the superintendent of the pumping station and a new water intake, suction wells, piping and electrical equipment inside the pumping station, together with a new force main which was required to supplement other force mains to accommodate a pumping rate per 24-hour day of 20,000,000 gal. The three units provided for one reserve unit while the other two units would be run together for a 12-hour shift.

In 1915 the city charter was revised and the office of commissioner of public works was created. The commissioner became the head of the water bureau. The question of metering was thereupon taken up with this official, and a scheme was developed whereby a pumping station could be erected in connection with the installation of meters. This would be much more economical in the end, and for its housing a portion of the existing pumping station could be used. The question of meters was taken up with a citizens' committee, and the whole plan of the combined meter and pump installation was finally accepted as the proper method of development.

Current Charge Based on Two-Hour Maximum

During 1916 and the early part of 1917 efforts were made to close a suitable electric power contract with the Cohoes Co., which would allow adequate credit for leases held by the city for the use of the old hydraulic canal. This contract was closed in the early part of 1917. The main point of interest in this contract, exclusive of local complications, is an electric rate of $20 per kilowatt-year, or about 0.228c. per kilowatt-hour, and the provision that the amount of current charged against any given quarter would be represented by the continuous use for that quarter of the maximum amount of current used during any continuous two-hour period.

In the autumn of 1916 contracts were let for remodelling a section of the present pump house to receive the new electric-drive pumping apparatus and for the first installment of meters, these meters being recommended in size and number to serve the principal industrial and commercial needs of the city. It was hoped that this first installation of meters would reduce the consumption by at least 1,000,000 gal. a day and that the future additional meters would bring the per capita water consumption down to about 135 gal. a day.

A definite electric-power contract having been made, meters purchased and a meter system adopted, it was possible to design a pumping station which would best suit the water-consumption and electric-power requirements in the case. In 1916 the average daily consumption ran to about 9,000,000 gal. a day during continued periods of cold or hot weather. The raw-water reservoir to which the pumps deliver had a storage of about 45,000,000 gal. which could be delivered to the filtration plant. It was assumed that the first installation of meters would be completed before the pumps could be placed and that in the meantime the excessive use of water during hot and cold periods would be materially reduced and the average consumption for the year would approximate about 5,000,000 gal. a day. The electric contract required, for economical operation of the plant, that the water pumped per day be as close as practicable to the consumption, since one day's pumping of an excessive quantity of water would create a power record of over two hours and this day's use of power would be the basis of the charge for the entire quarter irrespective of the reduced power used on subsequent days. The normal consumption of 6,000,000 gal. a day was to be reduced, and, in view of the storage of raw water available, it was considered that a normal maximum capacity of 7,000,000 gal. a day would be ample.

To meet the decreasing use of water due to the use of meters it was important that the units making up the plant should be graded downward, and it was decided to install three pumps, one of 1,000,000-, one of 4,000,000- and one of 6,000,000-gal. capacity. This combination of units made it possible to pump 4, 5, 6 or 7 million gallons per day by various combinations or an average of 4½, 5½ or 6½ million gallons per day.

It was also considered advisable to have the larger pumps of a characteristic curve such that when the 4,000,000- and the 6,000,000-gal. pumps were operating together they would not give their combined capacity but react against each other so as to yield about 7,500,000 gal. per day. In case these two large pumps were used together, inadvisedly, for a period of more than two hours, there would not then be an electric charge for a whole quarter resulting from pumping 10,000,000 gal. for a short period, and with a meter system the pumps designed provided ample capacity and ample reserve for many years to come. Population increase would be balanced by per capita reduction in the use of water, for which there was ample margin.

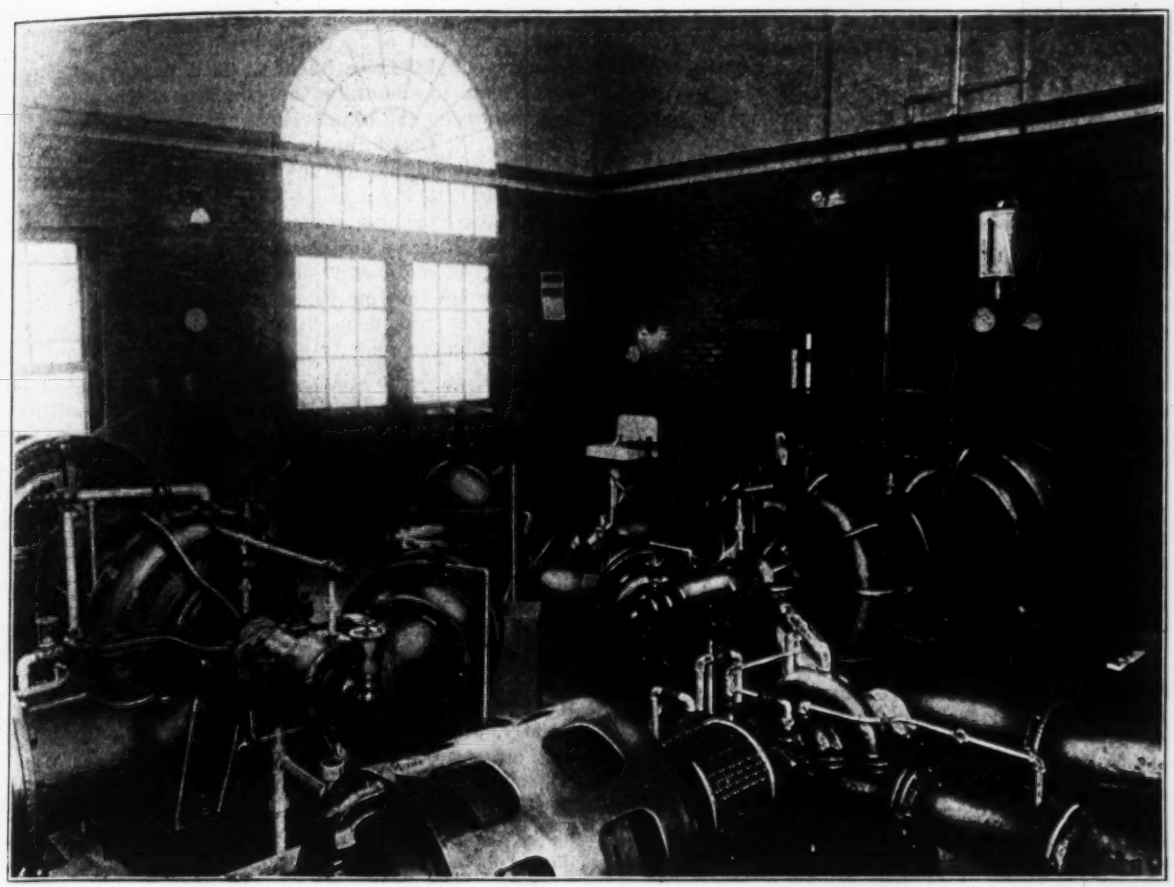
In designing the plant it was necessary to bring the discharge of the pumps to an existing elbow in the floor, which was embedded in a masonry arch and could not be disturbed. In order that the discharges could be separately valved, the parallel layout of the piping shown in the photograph was required with a true 16-in. Y having the inlet flange turned down to a diameter which would be received by the bell of a 20-in. pipe. Flexible joints were installed for the larger pumps, so that no undue strain would be transmitted to the pump castings. There are no gate valves or check valves on the suction lines of the pumps, but the pumps are primed by means of a rotary vacuum pump driven by an electric motor, with long-distance controls at the compensator starters for each pump motor. The air in the suction lines and the pump casings is exhausted by means of this vacuum pump. A small tank with a glass gage indicates to the operator when the suction lines and pumps are full of water. The vacuum pump is then stopped by the pushing of a button, and the motors are started. The motors are slip-ring motors, and a special interlock was installed in the compensator starters which makes it impossible for an operator to throw on the main switch of a motor if the compensator is in the "full-on" position. It is thus impossible to throw the full voltage across the motor in the operation of starting it.

Old Turbine Pit Made Into Suction Well

The suction well sumps consist of an old water turbine pit to which the water passes through float-operated butterfly valves. An electric-alarm float indicator also shows the operator the water level in the suction well and gives the alarm for high and low water.

A wall crane with a 24-ft. reach and containing a trolley and hoist is to be installed for removing the upper half of the pump casings, motor armatures, etc. The station is equipped with a full complement of electrical and hydraulic indicating instruments mounted on the electric switchboard and on the individual unit panels.

The three motors are 2300-volt, two-phase, 40-cycle machines. The two 4,000,000- and 6,000,000-gal. pumps are single-stage, double-suction, operating at 1170 r.p.m. against a total head of from 170 to 195 ft. The 1,000,000-gal. pump is single-stage, double-suction, running at about 2300 r.p.m. against a total head of about 185 ft. at full capacity. The small vacuum pump is operated by



THREE ELECTRIC-DRIVE PUMPING UNITS WORKED IN VARIOUS COMBINATIONS DELIVER WATER TO COHOES
The 1,000,000-gallon unit is in the foreground, the 6,000,000-gallon at the left and the 4,000,000 at the right of the view.

a 2-hp. motor and is capable of developing a 24-in. vacuum. By means of this pump any unit may be brought from rest to full pumping load in about 45 seconds.

The arrangement of the pump may be called radical. The large pumping units have center lines at right angles to each other. This leaves the motor end of the unit in a free space with no electrical apparatus adjacent to it and provides free access to all sides of both machines. Water from the pumps is deflected by a 45-degree fitting to the force main header which runs above the floor on the center lines of the pump discharge openings.

In the process of removing the old apparatus, and, due to lack of water in the hydraulic canal on Sundays, the level in the raw-water reservoir was considerably reduced. At the same time it was apparent that the consumption of water would average at least 7,000,000 gal. instead of 6,000,000 or 5,000,000 and, owing to lack of meters, the average requirements of the pumping station were unexpectedly increased.

The engineer realized that to meet this unexpected demand it would be necessary for the 6,000,000- and 4,000,000-gal. units to operate together to give a total pumping capacity of about 8,500,000 to 9,000,000 gal. A defective runner in the 6,000,000-gal. pump was replaced by a new runner, and in supplying the new runner the manufacturer furnished one with different characteristics, so that 6,000,000 gal. could be pumped against 180-ft. head. From this point backward the characteristic curve would rise as rapidly as possible and deliver as large a quantity of water as might be, against an increasing head, up to 200 ft. This runner was received and was found to operate successfully with the 4,000,000-gal. pump so as to produce a tota. quantity, against about 195 ft. of 8,500,000 to 9,000,000 gallons.

Lack of meters required this change in the pump design, and increasing consumption placed a load upon the pumping station such that continuous operation during periods from two to four weeks of both the 6,000,000- and 4,000,000-gal. units together would be required. As these facts developed, it was apparent that the reserve in the original design of the pumping station would be seriously impaired, and a reserve unit has been purchased.

The low cost of pumping water produced an unusual condition, affecting the question of metering as against pumping more water. A given number of meters would reduce the consumption of water by 1,000,000 gal. a day but it would cost only $700 per year to pump an additional 1,000,000 gal. Additional pumpage is temporarily cheaper. The metering policy, however, must eventually be adopted in order to prevent the impairment of the capacity of the existing reservoirs, the filtration plant, the force mains and the main conduits delivering filtered water to the city, and of existing pressures. Meters will doubtless be installed after a suitable educational campaign. The writer has been consulting engineer for the Cohoes water-works since 1914.

With the Divisional Engineers in a Great Offensive

What the Fighting Engineer Troops Had to Do When They Went Ahead Day by Day With the Infantry

By Charles E. De Leuw
Gates & De Leuw, Engineers, Chicago
(Late Captain, Engineers, United States Army)

ENGINEERING in the great war was so largely a matter of preparing for the actual fighting, and so great a proportion of the American Army engineers in France was engaged in the splendid work of the Service of Supply, that many in this country have never learned just what was the work of the engineer troops in the zone of advance. Censorship restrictions, too, did not permit those combat units much publicity. The writer was privileged to serve through the last months of the war with the Fourth Engineers, a regiment operating with the Fourth Division, in contact with the Germans, and his experiences there may give some indication of what the divisional engineer had to do, though no one man could have accurate first-hand information of any other than his own regiment.

Each infantry division contains an engineer regiment and an engineer train. The regiment proper consists of six companies, each with 250 men and six officers, and the headquarters detachment of 119 men. The engineer train contains both motor- and horse-drawn vehicles, and, in addition, each company is supposed to have four engineer tool wagons, two motorcycles, eight pack mules, the company supply wagons, rolling kitchen, and mounts for the officers. In service in France, as a rule they had all of these except the pack mules and mounts. The colonel of an engineer regiment is division engineer and adviser to the commanding general on all matters pertaining to engineering or construction work. It is his duty to keep himself constantly informed as to the need for work in the divisional area and to dispose of his unit to take care of that work. Engineers—and, as a matter of fact, all other troops—are auxiliary to the infantry, and in this war they were armed, equipped and trained as infantry, and for such engineering service as they might be called upon to do.

Division Engineers' Part in Trench Fighting

In trench warfare, divisional engineers are charged with the layout and construction of trenches and wire entanglements, the maintenance and drainage of trenches, the construction of dugouts and deep shelters, all mining work, provisions for sanitation and adequate water-supply, and the maintenance of paths and roads leading to the trenches. Immediately after an advance, when a portion of the enemy's trench system has been captured, it devolves upon the engineers to consolidate the new position—in other words, to make such new construction as to render the trench tenable when facing what formerly was the rear. This always includes the immediate erection of wire between the occupied trench and the enemy. If the trenches are to be abandoned, the engineers' job is to demolish all structures which will be of aid to the enemy and to place as many obstacles as possible in the path to obstruct his rapid advance.

In open warfare, or war of movement, the engineers are charged with duties that are somewhat similar, but which are, in the main, less complex. In an advance they repair and build roads, bridges, cut barbed wire and lay out defensive lines; in fact, do anything and everything to facilitate the advance of the infantry and the steady and uninterrupted flow of munitions and supplies to the infantry and the artillery. In a retreat—something, fortunately, in which the American Army had little experience—the engineers' chief mission is to destroy bridges, roads, railroads, and water-works and place as many obstructions as possible in the way of the advancing enemy. In many cases it is necessary to bolster up the line by putting engineer units in as infantry, as was done in the famous repulse of the German advance near Amiens in the spring of 1918.

When Our Engineer Units First Saw Real Fighting In the Open

The campaign having its origin in the great counter-offensive of July 18, 1918, extending from Soissons to Rheims, was the first in which the American Army had a prominent part, and in this action the Fourth Engineers first saw real service. About 10 American divisions participated in this campaign, which was strenuous in every sense of the word. There our engineer units had their first taste of open fighting, and their portion, as well as that of all other troops, was tiring and ceaseless work. Hard fighting took place within the Chateau Thierry salient, but it was of comparatively short duration, and consequently the roads and other structures were not completely destroyed, and in places were practically untouched. The retreat of the Germans out of the salient was so hurried that only occasionally did they have time to destroy roads and bridges, all of which simplified the task of the engineers. Nevertheless, the fighting had torn up the roads and bridges to some extent, and occasionally the Boche engineers had had time to mine a road or a bridge, so our engineer regiments had plenty of work. On roads filled with shell holes there was usually enough stone nearby for backfilling. Where the road had been mined, débris and demolished masonry in the nearest village was hauled to the site, or, if this was impossible, sand bags were used, filled with the best material at hand.

The bridges were all over comparatively small streams, and if it were impossible to repair the structure, a rough bridge which would serve temporarily was thrown up. Time was the only consideration. For foot bridges for use of the infantry, convenient trees were sometimes felled across the streams. In addition to this repair work, the engineers had to outline defensive positions during the advance. It was very necessary to play safe at all times and have a position outlined behind the advanced infantry, so that in case of a strong hostile counterattack the infantry would have a position ready to occupy. In this case outlining a position meant taping out a trench system or its main elements, after a careful reconnoissance. The machine-gun emplacements were dug, and at least one line of wire was strung in front of the position.

The writer knows of no better way to convey an idea of the life and experiences of these engineers than by giving a few extracts from some daily notes, necessarily brief and sometimes abrupt, made in the field during the Chateau Thierry fighting.

July 13—Finished the rifle range for the — Infantry today and moved the company to this town, which is about five miles from the lines. Made a reconnoissance of our new

work this afternoon with the major, most of the time in a pouring rain. Our job is to build lanes and communication trenches from here to the front line for the French. We were pretty close and I saw the German lines for the first time. Our work will not be dangerous, for we will work on the exposed spots at night.

July 16—Knocked out a good day's work on the trench system today, pretty well fagged out tonight. C company had a couple of men wounded today near us, the first in the regiment. Understand the Boche made quite a heavy attack east of here yesterday; we could hear the firing of heavy guns very plainly about 10 p. m.

July 17—Tonight starts our first big adventure; we go over with the infantry.

July 19—We came here with C company yesterday morning under fire, but no casualties. C company has gone up to Hautvesnes to construct a defensive position and we are bivouacked by the side of a sheltered road just east of Vinly, awaiting orders. We are in the counter-offensive from Chateau Thierry to Soissons. Our division and the French have been going splendidly—advanced 9 km. in 30 hours with light losses. The French regiment to which we are attached took 450 prisoners and 70 guns yesterday. The Boche is on the run at this point, the attack being a complete surprise to him. The fighting is open, what trenches there are being a very light type. The night of the 17th-18th was the blackest I have ever seen. There was a hard rain and a thunderstorm lasting half the night. It made the task of moving large bodies of troops up to the line very difficult. The roads were frightfully congested, and in the inky darkness many units had a hard time getting to their positions. They all got there on time as far as I know, and the infantry, our infantry which had never been under any sort of fire before, jumped off on schedule time and waded right through; some of them had hiked 20 km. in that mess of the night before, too.

July 22—Am sitting in an oat field near a small patch of woods. The fields all around are full of shell holes, and small cemeteries are thick. We have moved twice since the 19th, each time toward Germany. Have been doing trench work and road repairs, and D company is certainly going in great style; the company has had only three casualties.

July 24—Our division is going back for a rest and to get replacements, some of the infantry having had heavy losses. Our regiment fared well—only three officers wounded, all of whom will recover, I believe. What casualties we had were all from shell fire. Since the 17th we have moved practically every day, have dug trenches and repaired roads at all hours of the day and night. The most interesting thing I have seen is the short, terrible bombardment, which precedes the artillery attack. We were coming in from work the other night with the artillery back of us, when all at once they cut loose. I happened to be up on a high hill where I could see our shells bursting on the Boche, and it was a great treat. It was 4:30 a. m., and I ran the risk of being caught in an exposed position at daybreak to watch it awhile. It was superb.

Repairing Roads "For a Rest"

July 26—We are taking things easy back here. The billet I am in has been occupied by the Boche. We are repairing roads and building kitchens for the division, coöperating with B company. The other four companies are working on a defensive position. We are doing this for a rest.

July 28—Moved from our billets this morning and are now about nine miles east of there in territory occupied by the Boche within 24 hours. It is interesting to see what pains the Boches have taken to make this woods habitable. They have a profusion of dug-outs, and in every way it looks as though they had intended to stay here all winter. They abandoned an immense quantity of material here, as they have all along the line.

July 29—Moved again this morning, and are now bivouacked in a big woods with the entire division. We are still corps reserve, and I understand we are in an entirely American corps, the first time one has been formed during the war. The regiment is all together for a change.

Aug. 3—The division has been in front for two days. We are again in a large forest, the Fôret de Fère, I believe. Repaired roads and bridges today, covering about 16 km. of roads. Cleaned the débris out of the streets of Fère-en-Tardenois this morning; it was an awful mess. On returning to our bivouac found orders to proceed to the Bois de Dole, about 15 km. north of here. Will have good supper and start.

Aug. 4—Moved up here last night, roads almost impassable in spots due to recent rains. My transport did not get through so I hiked back to locate it; impossible to get anywhere on motorcycle. On roads again today. My company has had no sleep in 60 hours and has hiked that many kilometers.

Aug. 5—Getting a much-needed rest here in the Bois de Dole. Two companies have gone up to put foot bridges over the Vesle River for the doughboys. Another company reported to the — Brigade and is in the line. My company is ready to move on five minutes' notice.

Aug. 6—Made a reconnoissance for an artillery bridge over the Vesle yesterday afternoon with the major. We timed it rather poorly, as the doughboys were just going over and it was pretty hot. The Boche were actually sniping with one-pounders.

Met Machine Guns, Shells and Gas

Aug. 8—Have been assembling material for bridge. It has been hot down there. We are bothered with machine-gun fire in addition to shell fire, and the mustard gas is pretty thick. Our infantry still in the line and going forward slowly; they are holding the road on the other side of the river now. Cannot begin to describe the inferno down in that river valley. The Boche counterattacked this morning; they were supported by a heavy barrage which we had to go through. Their attack fell down when it met our machine-gun fire. The enemy has made a genuine stand here; our advance will soon have to cease, as we are approaching a point where our men are too fatigued to continue the work incidental to an advance.

Aug. 10—We are putting up our bridge. As the infantry have been stopped about 300 yards beyond the river, there is no hurry for an artillery bridge, and we are taking our time. Work at nights and go back about 4 km. to rest during the day.

Aug. 11—Work on bridge called off. Reconnoitered for a defensive position in front of Ville Savoye, just back of the bridge site, this afternoon. Took my platoon commanders along. It is getting hot in the little valley where we are camped. The artillery back there call it Death Valley. Ordinarily it is fairly quiet, but this morning the Boche got our range and I was waked up by some Boche shells. Looked out and saw a frightful slaughter of horses; cannot understand why the artillery keep their animals up here.

Aug. 12—Ordered to resume work on bridge; practically completed job. Working strength of company down to one lieutenant and 65 men.

Aug. 13—Division relieved, for which I am duly thankful. Our casualties were not so heavy, considering what we went through, but they were heavy enough. We all have our eyes burned a bit from the mustard gas in the valley. Joined the regiment today, and are glad to be back where the shells don't drop very often.

Aug. 15—Made a long hike last night and we are again in the Fôret de Fère, well back from the front now. We go back three days' hike and then entrain—do not know where we go. Some damfool at division headquarters has conceived the idea of having the engineers entrain the entire division. I am attached to the — Infantry; will hike back with them, then load them up.

The great campaign on the Meuse-Argonne front saw vastly different conditions and problems to be met. Here "no man's land" had been in the same general locality for four years. The terrific fighting around Verdun in 1915 and 1916 had effaced most of the artificial structures, and had greatly changed the natural features of the topography. Where roads had not com-

pletely disappeared, they were covered with two or three feet of mud. The entire country-side was one mass of churned-up earth, trench material, stone, and débris of all descriptions. On the morning of Sept. 26 the engineers went over thirty minutes after the infantry. Their principal task was to get the roads in such condition that the artillery could be gotten over them and ammunition push up. The infantry drove the enemy back about 10 km. the first two days and left behind them the most desolate looking mess imaginable. Let the imagination go as far as it will, and it cannot exceed the facts in this instance. On one road there were three regiments of engineers filling up the huge holes with sand bags, working with their hands, picks and shovels, using anything and everything to get that road in shape for traffic. The congestion on that road was terrific, and the daily rains served to add to the difficulties. The engineers often turned aside from their road making to put a truck or piece of artillery, which had slid into the ditch, on the road again. All of this was done under a hail of shell fire from the enemy. As everyone knows, these handicaps were overcome, and the campaign was finally pushed to a highly successful conclusion.

Compares Principal Plans for Railroad Policy

Equitable Trust Company Digest Shows Unanimity of Purpose, With Government Ownership Almost Without Support

THE digest and comparison of proposed plans for a future railroad policy, shown on the opposite page, and prepared by the Equitable Trust Co. of New York, indicate that all of the plans advanced "seek, in their final analysis, an adequate transportation system affording first-class service at rates which will not be burdensome but still sufficiently liberal to put railroad credit in the aggregate on a high plane, and which shall make it possible to pay the employees good wages," according to the statement of the company. It is pointed out that Government ownership is found to be entirely without support except from the railroad brotherhoods.

In *Engineering News-Record* of Jan. 2, 1919, p. 18, L. C. Fritch, vice-president and chief engineer of the Chicago, Rock Island and Pacific Railway Co., advanced "fourteen points" which he considered essential to establishing a sound railroad policy. In *Engineering News-Record* of Mar. 13, p. 504, Mr. Fritch suggested a more definite solution of the railroad problem, basing his article on plans which have been presented to Congress.

In commenting on the digest of the various proposals, the Equitable Trust Co. says:

"In the first place, we find that Government ownership is almost altogether without support, except from the railroad brotherhoods as represented by their counsel, Glenn E. Plumb. The predominance of opinion is for private control under restrictions, designed to promote better, more efficient service than was possible under the old system. The extension of Government control to the five-year period proposed by ex-Director General McAdoo likewise meets with little favor. In opposition thereto, it is argued that it would merely postpone the date of determining a problem which must come up for solution sooner or later; that it would tend to make the return of the roads to their owners more difficult; that it would place them in such heavy debt to the Government that liquidation or refunding would be practically impossible, and that there is nothing in the railway problem which cannot be solved in twenty-one months as well as in sixty.

"There is substantial unanimity that mergers should be permitted when in the interest of the public, and that the issuance of securities should be subject to Federal control. The latter subject is closely related to the question of Government guarantee of capital, for if the Government is to undertake the assuring to the roads of a specified minimum return, it is only logical that it should have something to say as to the creation of new securities, and accompanying new capital investment. The plans of the Association of Railway Security Owners, of Paul Warburg, and of Director General Hines, all contain provisions for such guarantee. The railway executives do not suggest anything quite so specific, but insist that rates shall be adequate as well as reasonable.

"The rate question, which is perhaps the most difficult of all to determine, is variously approached. There is a tendency to concentrate the rate-making power in Federal authority without, however, entirely destroying the power of the state commissions. This is in line with the sensible policy of eliminating, so far as possible, the conflicts which are inevitable where there is dual authority, or where the Federal authority may be hampered and its orders nullified, by state action. There is, moreover, a sentiment in favor of an attempt to arrive at some precise figure which will represent equitable compensation to the security holders. Several of the plans contain suggestions for profit sharing with labor, with the Government, or with both, in case profits shall exceed this figure. Here we have the community of interest idea, which has received widespread application in industry, proposed for a new field—transportation. The justice and economic soundness of its adoption will scarcely be questioned, though there will doubtless be conflicting ideas to be reconciled in working out precise details. From the standpoint of the security holders, the important features of a guaranteed minimum return, together with a division of profits above a maximum, means at the same time the elimination of uncertainty as the possibility of reduction of one's income below a certain feature, and the loss of opportunity for very marked appreciation.

"In other words, it would greatly stabilize railway securities and minimize their speculative features.

Suggestions for Financing

"The views in connection with methods of financing the roads are not at all in agreement. Particularly interesting is the novel proposal of Mr. Morawetz, who advocates the refunding of all existing securities by means of a fixed and continuing proportion of debentures and bonds. This would apparently give the debentures a high investment standing, and would still leave the stock sufficient equity, together with the minimum guarantee of $2.50 per share by the Government, to assure it of an investment character only moderately tinged with speculation.

"The successful features of Government operation are not to be lost with the return of the roads to private control, if the ideas of several of the authors of the various railway plans are carried out. The joint use of terminals, the elimination of competitive features which yield no additional public service, such as separate ticket offices, almost identical passenger train schedules, etc., may be eliminated in the interest of economy.

Adjustment of Wages

"Some thought has also been given to methods of settling wage disputes. Three of the plans quoted aim to set up permanent organizations for the handling of these questions. Presumably a regular line of procedure for obtaining hearings and appeals would be instituted. If found workable, this would provide the machinery for proper consideration of, and decisions upon, this very vital matter."

PROPOSED RAILROAD PLANS

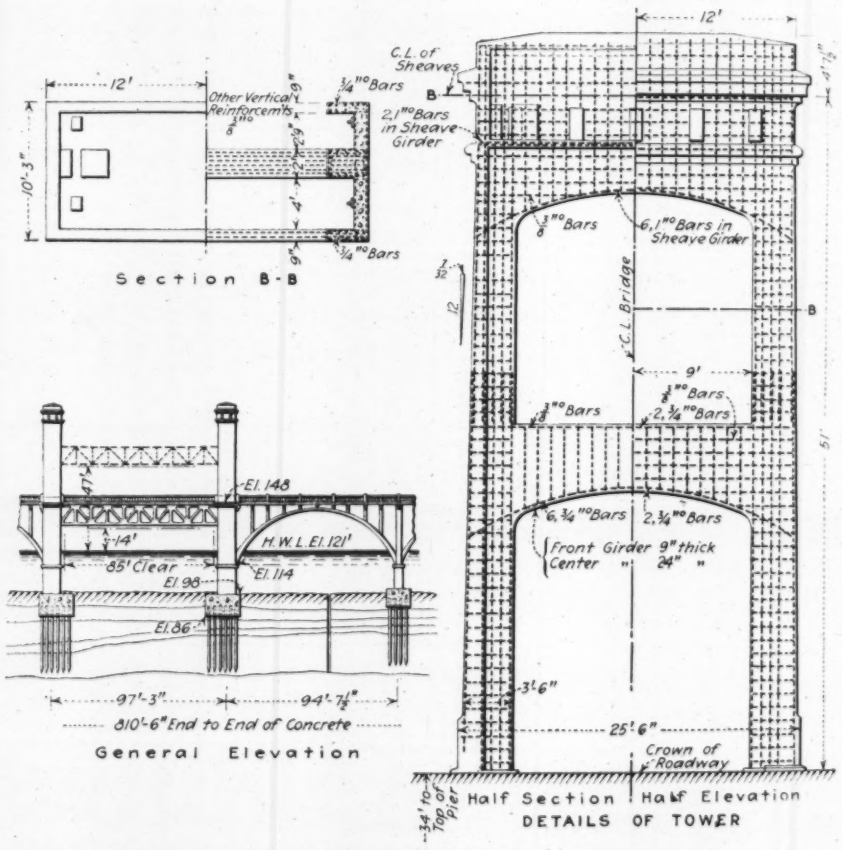
	RAILWAY EXECUTIVES	ASSOCIATION OF RAILWAY SECURITY OWNERS	INTERSTATE COMMERCE COM.	WALKER D. HINES DIRECTOR GENERAL	BROTHERHOODS	VICTOR MORAWETZ	PAUL WARBURG
OWNERSHIP AND OPERATION	Private.	Private.	Private.	Private.	Government ownership. Operation by private corporation run by employees, which pays government a rental out of the receipts of operation.	Private.	Private.
MERGERS	Federal incorporation with mergers allowed, subject to approval of Secretary of Transportation.		Mergers of existing companies may be made in the public interest.	Roads of each locality to be combined into regional systems, six to twelve in number.	Roads all to be operated by one private corporation, stock of which is to be held in trust for the exclusive benefit of the employees.	Railroads to be consolidated into ten or fifteen Federal corporations. Present securities to be refunded by 4% debentures and stocks.	Under Federal franchise, mergers may be made, subject to supervision of Federal regulating body.
REGULATION OF SECURITIES	Federal control exclusively.	Under supervision of Regional and Interstate Commission.	Federal regulation of the issuance of securities.			Debentures and stock to be issued only as authorized by Federal Railway Board.	By Federal regulating body.
CONTROL	A cabinet officer "Secretary of Transportation" to be appointed. Interstate Commerce Commission should be relieved of executive and administrative duties, ecept as to valuation and accounting, and act as quasi judicial body. Regional Commissions.	Federal regulation through Interstate Commerce Commission, as at present constituted, co-ordinating with six Regional Commissions-Co-ordination between State and Regional Commissions.	Better defined relationship between State and Federal control. A broadening of Federal control.	Five-year extension of Federal control. Modified private operation and control thereafter. Government representation on Boards of Directors.	No "Secretary of Transportation" continuation of powers of Interstate Commerce Commission. The directors shall be selected, one-third by non-appointed employees; one-third by appointed officers and employees; one-third by President.	Federal corporations to be under regulation of a Federal Railway Board headed by Cabinet Officer. Specified number of directors of Federal corporations to be appointed by Federal Railway Board. Regional boards and one central board of regulation.	Regional Board upon which State commissions might be represented with a reorganized Interstate Commerce Commission of 5 or 7, half judicial and half administrative in character at head.
RATES AND RETURN ON CAPITAL	Regulation of rates by Federal government exclusively. Carriers may initiate rates which shall become effective unless disapproved by Secretary of Transportation. Statute shall specifically provide for adequate rates, which must reflect cost of wages and other expenses. Rates may, upon complaint be brought before I. C. C. for review with power to prescribe minimum rates.	A minimum rate of return, fixed by Act of Congress, through rates adjusted as occasion may demand. Interstate rates to be left in hands of State Commissions.	Revenues should be "adequate" and "reasonable." No statement as to any change in the method of rate procedure.	Government to ascertain and guarantee railroads a fixed fair return.	Under regulation of Interstate Commerce Commission. When the government's share of the distribution of profits exceeds 5% of the gross operating revenues, reductions in rates should be made to absorb the 5%.	To be regulated by Federal Railway Board through central and regional boards; local rates to be referred to regional boards, through rates to central board.	Rates to be determined by Federal regulating body. Railroads accepting plan to be guaranteed 4½% on Federal valuation.
DISTRIBUTION OF PROFITS		Earnings in excess of fixed reasonable return to be distributed among employees, railroads earning them, and for certain improvements not to be capitalized in rate making.		Profits above the specified fair return are to be moderately shared in by the railroads and the government, possibly also by labor.	Government guarantees return on bonds issued in exchange for existing capital. Any balance over this is to be divided between operating corporation and the government for the purpose of enabling the Interstate Commerce Commission to reduce rates. The operating company will disburse its share to the employees, in proportion to their annual wages.	Government to guarantee dividends of $2.50; any distribution in excess of $4 to be divided with government. Government to have option to buy stock at any time at $85 per share.	Any return on capital between 6% and 7% to be divided with government and possibly with labor. All over 7% to go to government.
FINANCING	Provisions to be made for funding by the United States of indebtedness of carriers to it growing out of Federal control.	A Federal corporation directed by the nine Interstate Commerce Commissioners and eight railroad men to finance purchase of equipment from the Railroad Administration, purchase of new equipment, and financing of the return of the roads to private control.		Comprehensive program of capital expenditure during five-year period; probably to be provided partly by government; partly by roads themselves where able to borrow.	All financing to be done by the government.	Debentures to be issued to an amount such that interest requires 40% of operating income. Balance of operating income to be capitalized at 6% in stock.	
JOINT USE OF TERMINALS, ETC.	Subject to direction of the Secretary of Transportation; also other similar matters.	To be arranged, also rerouting of freight, etc., by above Federal Corporation.					
WAGES	This and similar questions to be settled by officers and representation of individual employees affected, if possible, otherwise by a board under the Secretary of Transporation.	Regional Commissions to act as Boards of Conciliation. Appeal to Interstate Commission.			A committee of nine directors of operating company empowered to make binding and final decisions in all wage disputes.		

Reinforced-Concrete Lift-Span Towers for Highway Bridge

BY F. H. FRANKLAND
Consulting Engineer, New York City

ECONOMIC studies for a reinforced-concrete highway bridge over the Osage River, near Jefferson City, Mo., on the main highway between Kansas City and St. Louis, showed that at the present prices for structural steel in place, reinforced-concrete towers for the lift span were not only about $4000 cheaper than structural steel towers, but the advantages from improved appearance and the use of more permanent materials were considerable. The difference in cost for reinforced-concrete towers, as against structural steel towers, above the roadway was found to be approximately $2000. Owing to the increased vertical reactions on the piers due to the use of the heavier concrete towers, it was found possible to reduce the width of the arch abutment piers, thereby saving an additional amount estimated at $2000.

The total length (810½ ft.) includes six barrel, open-spandrel arch spans, 92 ft. c. to c. of the piers; one steel deck-truss lift span, giving a clear horizontal opening of 85 ft., and a vertical clearance of 47 ft. above standard high water, and a series of continuous concrete deck girder spans at each end, each consisting of one 30-ft. span, two 20-ft. spans, and finished with an 8-ft. cantilever girder, which is buried in the approach fill. The pavement on the approach spans consists of a 2-in. concrete wearing surface, in which special aggregate is used, and on the lift span creosoted wood block on creosoted subplanking is provided. The lift span is operated by hand power, from a capstan at the center of the span actuating a worm reducing gear which is connected directly to the hoisting drum. The worm gear is completely incased in an oil-tight box, and runs in castor oil.



GENERAL ELEVATION AND DETAILS OF REINFORCED-CONCRETE TOWERS

The lift-span towers were designed to carry the load from the sheaves and also to take care of a 30-lb. wind stress. The sheave girder is designed for the sheave loads and wind stresses, and the other cross-girders for wind stresses only. In the upper portion of the tower the central 2-ft. portion of the column is assumed to carry all of the sheave load, the wind loads being divided between this 2-ft. portion and the two 9-in. portions. At the bottom of the tower all of the loads are assumed to be divided over the entire section of the column. Below the roadway surface the tower columns carry the deck loads in addition to the sheave loads and wind loads. The towers have been designed throughout with the minimum sections which it was found practicable to use and still retain ample clearances for the counterweight sheaves and the lifting girders on the movable span.

As there is a limited amount of money available for the construction of this bridge, the general architectural appearance of the towers is perhaps not quite as satisfactory as would have been the case if strict economy in design had not been enforced. However, by a judicious use of openings, as regards shape and spacing, and by slightly battering the outside faces of the towers, together with the use of a suitable cornice and molding, it is felt that a satisfactory æsthetic appearance has been obtained, while at the same time gaining the advantage of the use of permanent materials.

The structure was designed by the writer's firm, Waddell and Son, Inc., New York and Kansas City, consulting engineers for Cole and Osage Counties, Missouri.

The bridge has been designated as a Federal-aid project, and state aid has also been obtained by the counties interested. The engineers will supervise construction.

How to Make Isometric Working Drawings to Scale

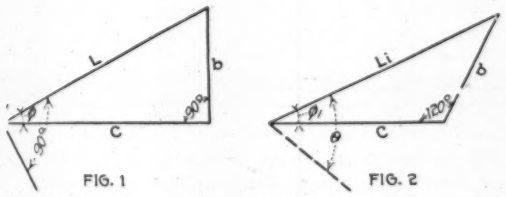
By George Paaswell
Civil Engineer, New York City

ISOMETRIC drawings are usually sketch attempts to visualize a more or less complicated detail, and used merely to complement working drawings. There is no reason why an isometric drawing cannot itself be properly dimensioned and scaled and used as a working drawing, thereby replacing sundry plans and sketches. With this in view, at attempt has been made below to give a few formulas and then develop tables from them, so that the ordinary draftsman will have no difficulty in making his isometric drawing as exact as his working drawings.

Lines parallel to the isometric axes are, of course, shown correctly to scale; nonisometric lines are not shown to scale. The following are some simple theorems in what may be termed isometric trigonometry, the application of which should vastly simplify the plotting and dimensioning of nonisometric lines.

Isometric Trigonometry

It is assumed that the axes of the figure have been so chosen that all lines of importance lie in planes parallel to the principal planes of the figure. The following theorems apply solely to such lines. Thus in Fig. 1, the lines L, b and c lie in a plane parallel to one of the coördinate planes adopted in space, and b and c are parallel to two of the coördinate axes. Fig. 2 shows the



FIGS. 1 AND 2. DIAGRAMS SHOW FUNDAMENTAL RELATIONS

same configuration in an isometric drawing. The lines b and c remain, of course, of the same length. The line L which made an angle ϕ with c, now makes an angle ϕ_i with c. The lines b and c which formerly were at right angles to each other, now make an angle of 120°. In Fig. 1, tan $\phi = b/c$; in Fig. 2, by the law of sines, $b/c = \sin \phi_i / \sin (180° - 120° - \phi_i)$, whence

$$\phi_i = \cot^{-1}\left(\frac{1 + 2\cot\phi}{\sqrt{3}}\right) \qquad (1)$$

If a line be drawn at right angles to L and in the same plane, it may be divided into two angles, ϕ and $90° - \phi$. The angle $90° - \phi$ becomes, in the isometric plane, from (1), above,

$$\cot^{-1}\frac{1 + 2\cot(90° - \phi)}{\sqrt{3}} = \cot^{-1}\frac{1 + 2\tan\phi}{\sqrt{3}}$$

and the original right angle now becomes

$$\cot^{-1}\left(\frac{1 + 2\cot\phi}{\sqrt{3}}\right) + \cot^{-1}\left(\frac{1 + 2\tan\phi}{\sqrt{3}}\right) \qquad (2)$$

Or, from $\theta = A + B$ and the trigonometrical formula

$$\cot\theta = \frac{\cot A \cot B - 1}{\cot A + \cot B}$$

by substituting the two angles in (2) for A and B, the value of cot θ reduces to $1/\sqrt{3}$, therefore $\theta = 60°$, and a right angle in space becomes an angle of 60° in the isometric plane. Hence angles complementary in space add up to 60° in the isometric plane.

From (1) with ϕ_i given, $\phi = \cot^{-1}\left(\frac{\sqrt{3}\cot\phi_i - 1}{2}\right)$ (3)

Table I gives values of ϕ_i from ϕ, and can also be used conversely with sufficient accuracy.

TABLE I—VALUES OF ANGLES ϕ AND ϕ_i

ϕ	ϕ_i	ϕ	ϕ_i	ϕ	ϕ_i	ϕ	ϕ_i	ϕ	ϕ_i
0	0	10	8	20	15	30	21	40	27
1	1	11	9	21	16	31	22	41	28
2	2	12	9	22	16	32	22	42	28
3	3	13	10	23	17	33	23	43	29
4	3	14	11	24	18	34	24	44	29
5	4	15	12	25	18	35	24	45	30
6	5	16	12	26	19	36	25		
7	6	17	13	27	19	37	25		
8	7	18	14	28	20	38	26		
9	7	19	14	29	21	39	27		

Again, to find relation between lengths L and L_i.

In Fig. 1, $L^2 = b^2 + c^2$

In Fig. 2, $L_i^2 = b^2 + c^2 - 2bc\cos 120° = b^2 + c^2 + bc = L^2 + bc$

From Fig. 1, $b = L\sin\phi$ and $c = L\cos\phi$, and $bc = L^2\sin\phi\cos\phi$ whence $L_i = L\sqrt{1 + \sin\phi\cos\phi} = kL$, where $k^2 = 1 + \sin\phi\cos\phi$

and conversely, $L = KL_i$, where $K = 1/k$.

Table II gives values for k and K.

To obtain the length of a line not lying in these so-called principal planes—i.e. planes parallel to the

TABLE II. VALUES OF COEFFICIENTS k AND K

ϕ	k	K	ϕ	k	K	ϕ	k	K
0	1.00	1.00	16	1.13	0.89	32	1.21	0.83
1	1.01	0.99	17	1.13	0.88	33	1.21	0.83
2	1.02	0.98	18	1.14	0.88	34	1.21	0.83
3	1.03	0.97	19	1.15	0.87	35	1.21	0.82
4	1.04	0.97	20	1.15	0.87	36	1.22	0.82
5	1.04	0.96	21	1.16	0.86	37	1.22	0.82
6	1.05	0.95	22	1.16	0.86	38	1.22	0.82
7	1.06	0.94	23	1.17	0.86	39	1.22	0.82
8	1.07	0.93	24	1.17	0.85	40	1.22	0.82
9	1.08	0.93	25	1.18	0.85	41	1.22	0.82
10	1.09	0.92	26	1.18	0.85	42	1.22	0.82
11	1.09	0.91	27	1.19	0.84	43	1.22	0.82
12	1.10	0.91	28	1.19	0.84	44	1.23	0.82
13	1.10	0.90	29	1.20	0.84	45	1.23	0.82
14	1.11	0.90	30	1.20	0.84			
15	1.12	0.89	31	1.20	0.83			

adopted planes of reference—it is too cumbersome and therefore of little practical value to establish general formulas. If the coördinates of the two terminals of the line are obtained, then its length is easily found from the expression

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

where $x_1y_1z_1$ and $x_2y_2z_2$ are the terminal coördinates.

In usual practice, however, it is possible to locate the planes of reference so that all the lines of interest lie in planes parallel to these reference planes. It is also usual to record on the drawing the true dimensions and angles, not the corresponding isometric values.

If a curve is given in space, lying in a plane parallel

to a reference plane, draw vectors to several points on the curves from the origin in the plane. The angles which these vectors make with the reference axis, and the lengths of these vectors, when properly reduced by the given tables, serve to locate the given curve in the isometric plane.

In the accompanying drawing, Fig. 3, is shown an isometric detail at the intersection of an abutment and retaining wall. The line of intersection of the two faces is taken as the vertical axis. The datum line 100 along the face of the retaining wall is taken as the x axis. The y axis is then drawn at the same elevation.

The angle between the abutment and the retainingwall is 70° or 20° with the y axis; from the tables the corresponding angle in the isometric plant is 15° and a line making this angle with the y axis in the isometric plane is drawn, giving the datum 100 along the face of the abutment.

All true dimensions parallel to this line are then multiplied by the coefficient k for 20°, 1.15 from Table II, to get the lengths in isometric projection. Similarly, all dimensions at right angles to the face of the abutment are multiplied by the same coefficient.

It is easy to see how, in making an isometric of a skew portal or of hips and valleys, etc., scale drawings can be prepared to give all necessary information properly dimensioned.

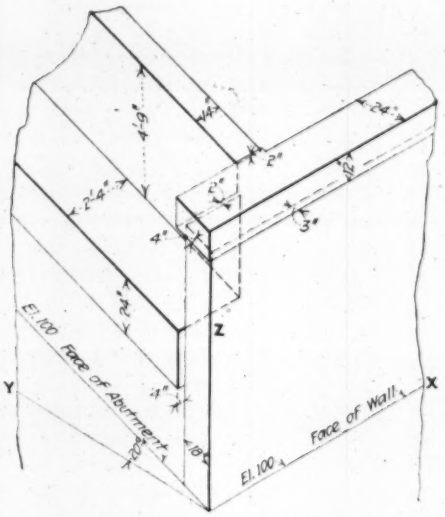


FIG. 3. INTERSECTION OF RETAINING WALL AND ABUTMENT

High Rate of Filtration Feasible for Detroit Water-Supply

Experiments Warrant Recommendation for Rate of 175,000,000 Gallons per Acre—Estimates for 300,000,000-Gallon Plant

RECOMMENDATIONS for a mechanical water-filtration plant for Detroit, with a nominal capacity of 300,000,000 gal. a day, operating at the unusually high rate of 175,000,000 gal. an acre after a retention of 13 min. in the mixing chambers and two hours in coagulation basins, have been made by R. Winthrop Pratt, consulting engineer, Cleveland, Ohio, in a report to the water commissioners. The estimated cost of the plant is $5,800,000. Under the "present rate policy," Mr. Pratt says, filtration and extra pumping "would cost domestic consumers 6c. per 1000 cu.ft., or less than 1c. a day per family." The high rate of treatment and low unit cost of filtered water mentioned further on are made possible by a relatively low turbidity and other favorable local conditions. The use of filter sand having an effective size of about 0.5 mm. will result in a large saving of waste water.

To obtain data that would be a safe guide in adapting mechanical filtration to Detroit conditions, a 200,000-gal. experimental plant was operated for a full year, ending Sept. 30, 1918. A description of this plant and a summary of the operating results are given in the report. It may be noted also that pains were taken to write a report that should be readily understood by the citizens and voters of Detroit; also, during the tests filtered water was piped to a plate-glass tank for public inspection, and visitors were encouraged to carry away filtered water. The booth covering the tank also contained a model of a filter and samples of turbid water.

The plant is designed for a regular working capacity of 288,000,000 gal. (72 filter units at 4,000,000 gal. each) which may be increased temporarily to 300,000,000 gal. Provision is made for enlargement to a nominal capacity of 450,000,000 gal. a day. The velocity in the mixing chambers would be 1.4 ft. per second and in the coagulation basins 3 ft. per minute. A 36,000,000-gal. clear-water reservoir is provided for.

The cost per 1,000,000 gal. of treating 250,000,000 gal. a day, including low-lift pumping, is estimated at $7.91, divided as follows: Low-lift pumping, $1.60; coagulation and filtration, including waste water, $2.06; capital charges, at 6.505%, $4.22.

During the experimental year the average turbidity of the raw water was 30 p.p.m. On 205 days of the year the turbidity exceeded 20 p.p.m. and on 39 days it was over 50 p.p.m. The maximum turbidity for the year was 490 p.p.m., on Apr. 12.

The tests indicated that alum would be cheaper and less troublesome than iron and sulphate of lime for coagulant.

Typhoid statistics from the Detroit Health Department, quoted in Mr. Pratt's report, show an average death rate of 13.47 per 100,000 for the past six years, ranging from 25.70 for 1913 to 7.45 for 1918. With the exception of 1913, the highest rate was 12.9 in 1917.

The investigations on which Mr. Pratt's report is based were in immediate charge of F. H. Stephenson, principal assistant engineer.

Engineers and Lawyers on a Par

County highway engineers in Missouri are considered by certain legislators to be worth at least as much as lawyers. In Senate Bill No. 427, under the heading "Compensation" the following clause appears: "The county highway engineer shall receive the same compensation as is now provided by law for the prosecuting attorneys in the various counties of this state, and his salary shall be computed and paid on the same basis as now provided by law in relation to the office of prosecuting attorney."

Segment Blocks Have Advantages on Larger-Size Drains

Lightness, Ease of Handling, and Small Breakage Are a Few of the Desirable Characteristics—Trouble with Unstable Soils

By D. L. Yarnell

Senior Drainage Engineer, Bureau of Public Roads and Rural Engineering

ALTHOUGH segment blocks have been used in the construction of sewers for some time, their entrance into the field of tile drainage has been only within recent years. Segment blocks are somewhat similar to building blocks in that they are hollow, with interior walls so arranged as to obtain the maximum strength. They are made of clay, vitrified and salt-glazed, with tongue-and-grooved side joints and with either square ends or ship-lap end joints. In sewer construction the aim is to have a water-tight conduit, while in drainage work the joints should be only closely butted together in order to permit water to enter the drains. Thus in sewer construction all joints of segment blocks are cemented.

In drainage work, usually, none of the joints is cemented. However, in main drains of large diameter the necessity of permitting the water to enter the joints is not so important, since the submains and laterals deliver the water to the main, and cementing might be desirable, but, to make the contractor cement all joints to give additional strength would increase the cost of constructing segment-block drains. Manufacturers of segment-block conduits in many cases have underbid manufacturers of large concrete tile.

Comparative Cost of Segment-Block and Solid-Tile Drains

Although segment-block drains of 30 inches in diameter are made, the smallest size used in drainage work, so far as the writer knows, is 36 in. The largest segment-block drain laid, to the writer's knowledge, is 52 in. in diameter, while the largest concrete tile manufactured is 50 inches.

It is interesting to compare the costs of the solid tile with segment blocks. The following table gives comparative costs obtained during July, 1917:

PRICES PER LIN.FT. F. O. B. FACTORY

Size In.	Segment Block (No. 2 Grade)	Cement Title	Size, In.	Segment Block (No. 2 Grade)	Cement Title
30	$1.08	$1.175	40	.....	$2.040
32	.....	1.275	42	$1.62	2.250
33	1.19	.....	44	.....	2.475
34	.....	1.425	45	1.74	.....
36	1.30	1.650	48	.....	2.940
38	.....	1.875	50	.....	3.200
39	1.51	.....			

On the Hamilton County, Iowa, Drain No. 4, the bids received for 3750 ft. of 39-in. tile delivered along the line of drain were as follows: Solid tile, $11,452; segment-block, $8851 and $8993.

The complete bids received on this drain for labor, and furnishing and hauling tile, were as follows: Using solid tile, $15,500; using segment-block, $12,800.

From these data it may be inferred that the cost of installing segment blocks is about the same as for solid tile; however, that may not be true under all conditions. It should be noted that this drain was laid in the bottom of an old ditch, the average cut being about six feet.

On the Webster, Hamilton and Boone Counties, Iowa, Joint Drain No. 1-192-210, bids on the following size of tile delivered along line of drain were received: 1460 ft. of 52-in., 850 ft. of 48-in., 600 ft. of 42-in., and 6250 ft. of 39-in. A segment block manufacturer was the lowest bidder and was awarded the contract at a cost of $23,895.

Difficulties with Segment Block Drains

In construction the contractor lays the invert block to grade. The other blocks are then added, and the space around the tile is filled with earth. The last block on top, the key block, is usually slipped in place by hand, few drainage contractors using the arch form recommended by segment block manufacturers. The arch form consists of an adjustable semi-circular form mounted on a V-shaped frame. This form is designed to facilitate the laying of the upper blocks of the drain, being pulled ahead in the drain as the construction progresses. Of course, all joints on the drain are staggered.

If either tile or segment block drains are laid in trenches constructed in stiff soil where sheeting is unnecessary, excellent work can be done. The writer has seen segment block drains laid so true that the most exacting person could not find fault. However, in unstable soil, where sheeting is necessary, some trouble may be experienced after the blocks are laid and before the trench is back-filled. So far as the writer has observed, no failures have occurred after the trench has been back-filled. When the soils are unstable the lateral pressures in some cases are so great, before the trench is filled, as to cause the drain to collapse. The resistance of the drain to lateral pressure is increased by back-filling. Where sheeting is necessary, the back-filling must sometimes be done before the sheeting can be removed, and the contractor must leave it in. Resistance of the drain to lateral pressure can also be increased by cementing the joints. By leaving an occasional joint between the ends of blocks uncemented, water can be admitted to the drain. In back-filling the drain, great care should be exercised to see that the earth is carefully tamped between the drain and the side of the trench, until it is well above the springing line. Even in the best of material the trench should be back-filled as rapidly as possible after the blocks are placed.

The limit to the size of clay drain tile (due to the limits in size of machines used in manufacturing), is approximately 30 in., and for concrete tile, due to handling, about 50 in. Thus the segment block, on account of easy manufacture and handling, fills an important need for the larger sizes of drains. With large tile, where sheeting is necessary, the bracing must be far apart to admit the large tile. With segment blocks this trouble is eliminated.

The comparative weights of segment blocks and concrete tile are given in the following table:

	Segment Block		Concrete Tile	
Size	Weight per Block	Weight per Lin.Ft. of Drain	Weight for Each Tile	Weight per Lin.Ft. of Drain
In.	Lb.	Lb.	Lb.	Lb.
30	54	270	750	300
36	54	324	1,100	440
42	58	406	1,800	600
48	72	504	2,355	785

Thus it can be seen that the lightness of segment blocks constitutes a great factor in the shipping and

hauling of material. The segment block is compact and light, compared with solid tile. The loss due to breakage is not so great, since, if a block is broken the loss is slight, whereas if a concrete tile is broken, one entire length is gone. With a 42-in. drain the loss due to breakage of one segment block is 12c., as compared with $2.25 for a broken concrete tile. In spite of the difficulties of construction in unstable soil, there is no doubt that the use of segment blocks for tile drains will increase, due to the lightness and convenience of handling and the advantages in laying.

The above investigation was made and the report prepared under the direction of S. H. McCrory, chief of drainage investigation, Bureau of Public Roads and Rural Engineering.

Assembled Curves and Radii Diagram Aid in Railroad Drafting

By Dwight Gerber
Pittsburgh Terminal R.R. and Coal Co., Pittsburgh

TWO diagrams, illustrated here, have been found useful by the writer in handling railway curve work in the drafting room.

Fig. 1 shows a plan for assembling all curves ordinarily used—with a short tangent and the tangent point indicated on each—on one sheet of tracing cloth. The curves are arranged to facilitate the choice of a particular curve through intersecting predetermined points.

A little use of such a sheet as this will demonstrate the ease with which a choice of curves can be made, as compared with the usual method of sorting curves on a fit-and-try method. It will be self-evident how to use the curves drawn to the scale of 100 ft. to the inch in connection with other scales. Even though none of the scales as drawn will fit exactly, it is very easy to make a close approximation by interpolation of what curvature will fit.

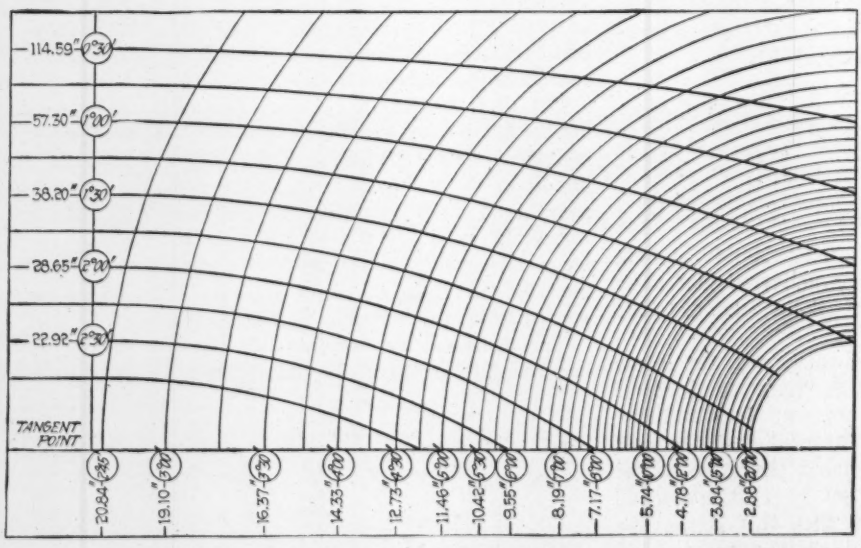


FIG. 1. PLAN (NOT TO SCALE) FOR LAYING OUT ALL CURVES WITH SHORT TANGENTS ON ONE SHEET OF TRACING CLOTH

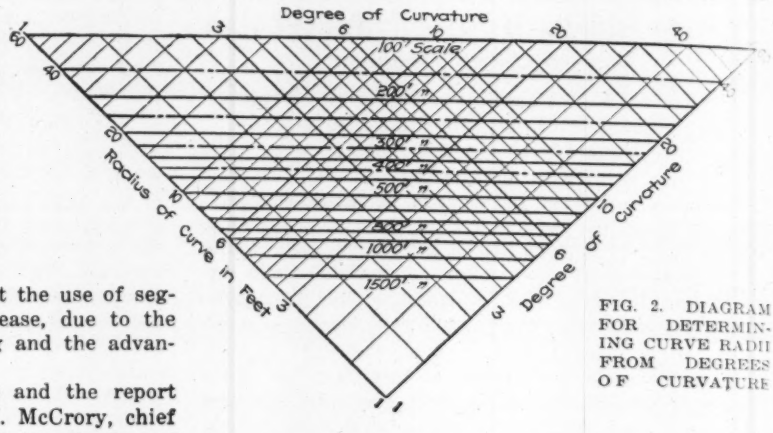


FIG. 2. DIAGRAM FOR DETERMINING CURVE RADII FROM DEGREES OF CURVATURE

A second sheet will be found very convenient in laying in a compound curve.

Fig. 2 shows a line chart which will serve as a ready reference to check the calculations of curve radii, which are usually made mentally and are often in error. The chart is laid out on logarithmic cross-section paper. The horizontal lines indicate the degree of curvature, the vertical lines the radii of curves, and the diagonal lines the various scales as marked.

As an example of the use of the chart, to find the radius of a 2.6° curve on a scale of 350 ft. to the inch, follow the horizontal line designating 2.6° to the 350 diagonal, then read down 62.9 feet on the vertical line.

Heavy Construction Marks New Pacific Coast Railway

The line of the San Diego & Arizona Ry., now being built across Laguna Range in California to connect El Centro with San Diego, traverses some remarkably rugged country that called for heavy construction. A map and profile of the line appeared in *Engineering News-Record* of Oct. 22, 1918, p. 365. Through Carriso Pass the grade has been kept down to 1.4%, because the cost of reducing grade later would be prohibitive. Elsewhere the grades run up to 2.2%, with 10° maximum curves. In the 12-mile section of the railroad that lies between Jacumba and Carriso Gorge there are 17 tunnels. Of these, two are about 2500 ft. long, one is about 1200 ft., and the remaining 14 are between 180 and 900 ft. The formation was loose, so that 75% of the total length required timbering. There remains to be completed a length of about 11 miles of the mountain division, and crews are now working on both ends of the gap. It is expected that the line will be ready for operation some time during the coming summer.

American Engineers Kidnaped by Chinese Bandits

Chief Engineer of American Company Building Chinese Railways Was Kept in Captivity for Nearly Two Months

SOME few outposts of civilization remain where the engineer is still pioneering, where the adventures so common in the engineering of a half century ago and between the covers of the modern novel may be had for the asking. One of these places is China. Over there, nearly a year ago, a little band of engineers, almost totally neglected in the clamor and publicity of the great war, went through an experience that ought to make good reading for those boys who wonder what they are going to do for excitement now that the war is over. One of the men, a prominent American railway engineer, George A. Kyle, has just come home from the Orient, and, on urging, has been persuaded to tell the story of his misadventure.

Mr. Kyle was the engineer selected by the American International Corporation to take charge of the construction of the railways in China for which the American Siems-Carey Railway & Canal Co. took a contract a few years ago. He left this country in November, 1916, and from the time he reached China until last spring he was engaged in the supervision of the several lines the company had under way. One of these was projected to extend from the main line of the Pekin-Hankow railroad due west a distance of about 900 miles into the Szechuan valley.

In March of last year American newspapers carried a brief paragraph to the effect that two American engineers had been taken into captivity by bandits operating in one of the eastern Chinese provinces. There was plenty of other excitement in the world just then, and the item did not reach much prominence, nor were the men heard of again until some time in May, when it was announced that they had been freed. Mr. Kyle and E. J. Pursell, a construction man with the company, were the two white men who were captured.

They had started Mar. 2 with a staff of Chinese engineers and servants, about forty in all, on a trip to the western end of the Szechuan line, where several engineering parties were working. They were accompanied by a police guard from Pekin and about 25 so-called soldiers assigned to them by the Government, because reports from time to time came into headquarters indicating that bandits were operating in the districts through which they had to pass. The men, however, were not particularly concerned regarding the dangers which they might encounter.

The Capture

After they had gotten some forty miles out of the town of Yen Shiang, which was the last headquarters of the railway forces, their caravan, made up of 18 two-wheel carts drawn by mules, was attacked without warning by a gang of bandits lying in ambush some hundreds of yards off the traveled road. The first notice was a fusillade of gunshots, on hearing which Mr. Kyle and Mr. Pursell, together with some of the loyal servants and two high-class Chinese who were with them, made for a nearby Chinese village behind its walled inclosure or compound. When they got there they found the soldier guard missing, nor were they heard from again except for some desultory firing on the bandits after the Americans had been captured.

Within the compound the small remaining party began a vigorous defense, but they were soon convinced that they were bound to be overcome by weight of numbers alone, to say nothing of force of arms, for the robbers were apparently well armed with modern rifles. Besides the servants, there was an engineer named T. C. Hu, a graduate of Cornell University, who was the Government representative for the inspection of the work which they were about to visit, and an American citizen of Chinese birth named Wu, who acted as interpreter. These four, the only ones armed in the party, threw away their revolvers and made signs of surrender, whereupon the bandit crew entered the compound and, to the surprise of the Americans, opened fire with revolvers at about 15-ft. distance. Thanks to poor marksmanship, there was no damage except a cut in the shoulder of Mr. Kyle's coat. The loyal Chinese managed to persuade the bandits of the completeness of the surrender, however, and they immediately took possession of the party and all their belongings, which included about $14,000 in silver, pay being taken out to the engineering party.

Lives in Constant Danger

In no recent time has any white man been taken captive by the Chinese bandits who roam the country apparently at will, and neither Kyle nor Pursell was very much concerned about his personal future once the gang had appropriated all the property of the party. They were, therefore, much surprised when the bandit chief announced that the two white men and Wu, the interpreter, were captives, though for what reason he did not then choose to tell. He straightway started the three men on a rapid march into the mountains, a strenuous trip taking about eight days. During all this time they were fairly well cared for as to food, but they were constantly being threatened by the members of the band and apparently in constant danger of being the victims of sudden temper on the part of some individual. After they had gotten well back into the wilds, it then being Mar. 12, the bandit chief announced that they were to be held for ransom in the following amount: Two hundred rifles with 200,000 rounds of ammunition and 200 automatic revolvers with 100,000 rounds of ammunition. The bandits themselves were well armed at the time and were apparently quite competent to take care of the modern firearms which they carried, though they were anything but good shots. It was agreed by the bandit chief that a message to this effect was to be delivered by Pursell to a Roman Catholic priest, named but not identified, and that the material was to be delivered by Mar. 25 on the penalty of the deaths of Kyle and Wu, who were to be held. For some reason the scheme fell through, and the march continued.

In the meantime Hu, the Chinese engineer, had escaped from the compound and back to the telegraph office where he notified the American legation, the Siems-Carey headquarters and the Chinese Government of the state of affairs. Immediately all kinds of machinery were set on foot to effect a rescue. It was very difficult, however, to know what move to make. The country where the bandits roam is very wild and absolutely without Governmental control, except that of the heads of the province who in a way are kings unto themselves and not much concerned about the possible

anger of the United States Government. Headquarters at Peking and all the Americans hesitated to send troops because of the fear of injury or death to the captives.

After the ammunition proposal fell through, for some reason unknown to the captives, they were taken every night on marches into country strange to all of them, even the native. They walked from 10 to 30 miles every night, sleeping in various towns or under cover in the daytime. As far as they were able to find out afterward, they were walking in circles, and were never more than 100 miles from the compound where they were captured. The only daytime walk that they made resulted in an incident which Mr. Kyle thinks was planned in advance in order to intimidate the captives. One afternoon, about four o'clock, they started out on a short march and went by a little village. Apparently all the villagers were gathered outside the compound to look at the procession, and one of the native men was summoned by a wave of the hand to come close by. He got within a short distance, when he was killed by a rifle shot by one of the bandits who then rushed the village and killed twenty-two of the villagers.

While this was possibly the ending or the middle of a feud between the bandits and the villagers, it is Mr. Kyle's opinion that it was "staged" so that they could realize that the men were dangerous and desperate characters. Immediately thereafter the chief of the band told Mr. Kyle that he must not have soldiers sent after him or the same sort of thing might happen. He did allow him, however, to send back messengers, who, by some unknown means, got Kyle's notes to Mr. Hitchcock, the representative of the railway company; the latter had by that time established himself at Yen Shiang. As a result of some of these messages, a little canned food was sent to the captives occasionally, but for the most part they had to live on what the natives could produce and what the bandits took with them. The bandits were always fairly well treated wherever they went, probably because they were known for the desperate character they undoubtedly won, though the Americans often thought that the gang was made up of a number of ostensibly peaceable farmers and villagers who took up banditing as a side line.

Attempt at Rescue

On Mar. 25, without warning that the Americans heard of, 500 Chinese soldiers crossed the path of the bandits and their captives and began an attack. A rearguard action was forced by the bandits, and the three captives were hurried off as fast as possible toward the mountains. They got to the top of the highest peak of the country and were starting to go across into another district when the bandits found they were surrounded by the soldiers, and the three captives, with four guards, lay flat on a hill while the heavy fighting was going on all around them. Here, the three thought, was an opportune time to escape, and all started to run. Kyle became separated from Pursell and Wu, who were guarded by one man only. They finally bribed this man to let them go, offering him a job as servant, which, curiously enough, he accepted. They escaped to the soldiers after being in captivity 22 days. Kyle's guards, however, stuck close by him through the fight.

Following this running battle, which lasted almost 24 hours, the bandit group, which comprised 85 to 100 men at first, was divided into small bands, one of which, consisting of seven men and the bandit chief, took Kyle with them into the mountains. They had a hard time escaping from the soldiers, but managed to break through after several attempts to get by pickets. Kyle might have escaped once when he was running along level ground and came to a deep vertical pitch over which all the men scrambled before him. Bullets were whizzing all around him, however, and he decided it was safer to follow his bandit captors down into the gully, protected from rifle fire, than to stay on top, possibly to be wounded or killed by the soldiers before they knew who or where he was.

When the bandits captured Kyle they had in their possession 17 native Chinese prisoners, whom they were holding for a ransom of $20,000. During the battle with the soldiers these prisoners escaped, much to the chagrin and anger of the bandits. Thereafter they were particularly careful of Kyle, because he was their only source of revenue. He never did find out, though, for just what ransom or reason they were holding him, although in certain conversations with Wu, before the latter escaped, the bandit leader intimated that all he wanted was enough arms and ammunition to set up as a soldier chief. Evidently, in that country political advantage is gained mainly by force of arms. At any rate, after Wu got away Mr. Kyle had no means of communication with his captors except by signs, and was ignorant of their intentions or of the progress of any negotiations for his release.

Final Period and Release

The night after the battle Mr. Kyle and his seven captors walked about 25 miles, out onto the Hunan plain. From that day, Mar. 25, they began a vagrant wandering at night, putting up in the daytime in villages where their hosts were very evidently in league with the band. At one time they crossed the railroad at a place which Kyle decided afterward must have been not more than 10 miles from Yen Shiang, where Mr. Hitchcock was conducting a campaign to reach him. Kyle managed to get occasional word via the underground messenger system to Hitchcock, but at no time did Hitchcock or any of the other Americans know just where he was. All during this time the seven men treated Kyle pretty well, though he had not had a bath for thirty or forty days and no change of clothing. The food was enough to keep him alive, although it was anything but good. Many times during the period from Apr. 1 to Apr. 12, when they were around railroads, he saw and heard trains going along, but could not get in touch with them.

On Apr. 21, however, he received in a letter from a native Roman Catholic priest the first real message from his friends. It was quite vague, but intimated that relief was assured. On Apr. 23 the party moved to a larger compound, where a Chinese Roman Catholic priest met him and told him that in two or three days he would be released. From then until Apr. 25 he was treated royally. On the latter day a local celebrity came along and took him, with the seven bandits, to Wu Yiang, where there were representatives of General Chang, one of the strong Chinese leaders. By the time they reached Wu Yiang a group of 3000 natives was marching alongside of the party, and the entry into the town was made with considerable ceremony. There Mr. Kyle found waiting some of his friends and, what he quite as much appreciated, his Chinese "boy" with a

change of clothes, and the monopoly for the day of a local bath house. It turned out that General Chang, knowing the ambition of the bandit leader, had sent the priest out to dicker, with the promise, in return for Kyle's life, of immunity from punishment and a captaincy in the Governor's bodyguard, together with positions as soldiers for the seven remaining men. The bandits agreed to this and, so far as Kyle knows, the agreement has been kept. He was in captivity 52 days.

Mr. Kyle thinks he never was in danger of his life after the first two men had escaped, but before that the very size of the gang made anything possible. The leader seemed to be pretty decent sort of pirate, who played fair and realized the value of the captives. The gunmen themselves, though, were blithe spirits who amused themselves by sticking a gun in a white man's ribs, and playing with the trigger. It was always about an even chance that one of them would consider pulling the trigger the final word in humor.

Relieving Arches in Subway Distribute Stress to Piers

Engineer's Special Design Meets Difficult Loading Conditions Imposed by Architect's Design—Groined Arches Used in Street Subway Under a Park

ARCHED sidewalk spans seated on the haunches of the roadway span in order to insure the desired distribution of stress constitute the distinctive feature of design in a three-span subway carrying a street under the grounds of the Iowa state capitol in Des Moines. The spans are groined arches with widely spaced piers instead of continuous bents for the intermediate supports. In the sidewalk spans these arches form a false roof concealing the structural or load-carrying arches. In carrying out the extension of the grounds or park it was necessary to extend a plateau south of the capitol and across Court Ave. to the crest of a bluff. At the same time it was desirable to avoid having the park intersected by a street, especially as Court Ave is a heavy-traffic thoroughfare forming one of the main routes between the city and the district beyond the capitol. The plan adopted, therefore, was to maintain the normal high level on the new fill for the park extension and to lower the grade of the street, carrying it under the park by a concrete subway.

SUBWAY UNDER IOWA CAPITOL GROUNDS HAS GROINED ROOF

From 4 ft. to 6 ft. of fill covers the structure, this depth being sufficient to allow planting of shrubbery. Tile drains are laid along the arches, leading to vertical drains in the piers. These piers are about 9 ft. square, and are spaced 38 ft. on centers longitudinally.

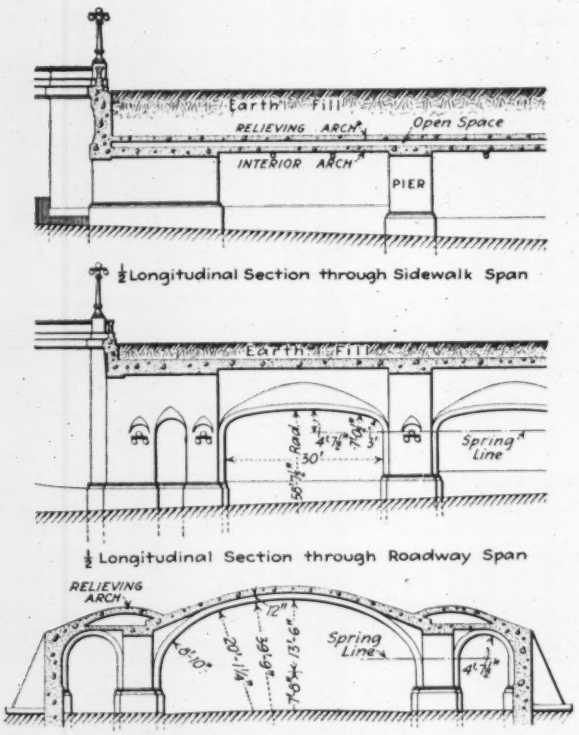
The visible or apparent span is 48 ft. clear for the central arch and 9½ ft. for the sidewalk arches. As the park surface and the crown of the arch are horizontal, while the street has a grade of four per cent., the height is different at the two ends, giving a different appearance to the portals. Thus, at the upper portal the height is 21 ft. 2 in. for the central arch and 13 ft. for the side arches, while at the lower portal these heights are 26 ft. and 19 ft., respectively. The length between the portals is 316 feet.

Architectural design of massive and monumental character is employed, and the bridge is flanked by long and high retaining walls on the street lines to retain the fill. On one side the wall has a curved return, with a winding stairway carried around its face. As it was intended that Court Ave. should have a street-car line, this stairway would accommodate visitors and employees. Reinforced concrete is used throughout, except that the portals have a decorative facing of Bedford stone and ornamental parapets of the same material. Electrical fixtures of bronze will be placed when the price of metal is lower.

Engineering conditions of the design were dictated largely by the architectural requirements, as follows:

The great difference in length between the roadway span of 49 ft. and the two sidewalk spans of 9 ft. 3 in., together with the prescribed outlines for clearance and æsthetic purposes, introduced a peculiar problem. It became apparent at once that resort must be had to some special expedient, in order to confine the line of pressures within the piers located along the curb line. Many schemes were tried and 14 different arch combinations were investigated. The adopted design consists of a relieving arch on either side, supported at one end on the haunch of the roadway arch and spanning over the sidewalk arch to the abutment. The visible sidewalk span is thus only a false arch.

The thrust of the relieving arch is introduced at such a point in the roadway arch that the resultant



SECTIONS SHOW DETAILS OF SUBWAY WITH GROINED-ARCH ROOF

of the two and the pier load fall within the prescribed outline of the pier. General reinforcement in the arches was introduced for its toughening effect, to prevent localization of any shrinkage, temperature or settlement strains in unsightly cracks.

The retaining walls and arch abutments are designed of the gravity, reinforced-cantilever or reinforced-counterfort type, as the interest of economy indicated for the several heights. It was thought that the curved plan of some of the walls offered opportunity for economy by taking advantage of the fact that such a wall, considered as a whole, has a greater stability, proportionately, than has any unit of its length. This was found to involve an analysis far more scientific in character than is warranted by any available data on earth pressure and foundation reactions. The curved walls, therefore, were designed on the same basis as the straight walls.

The live load for which the bridge was designed was assumed to be a fill 1 ft. deeper than the actual grade line, this excess providing ample allowance for any additional load reasonably to be expected. Unbalanced live load was given full consideration, but was found to make very little difference in the line of pressures. An effort was made to approximate the stiffening effect of the groins by figuring those sections of the main arch as having greater moment of inertia than that obtained by the formula $(bd)^3 \div 12$. This proved to be a refinement of theory without practical result, and it was abandoned in the later calculations.

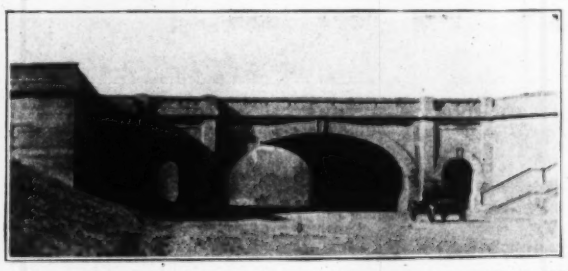
Features of Design—Owing to the fact that each relieving arch springs from a position on the haunch of the main span at which the transept and main arches act to stiffen each other, it was considered proper to analyze the relieving arch on the assumption that its abutments are rigid.

The stress conditions in the groins were investigated on the following basis: The line of pressure of an arch as usually determined is really a cross-section of a surface of pressure. The surfaces of pressure for the several intersecting arches were intersected in lines corresponding somewhat closely with the physical groins of the arches. These lines were then divided into short segments, the thrust of each arch was determined for each segment of the intersection and, being concurrent, these forces were readily composed into a resultant thrust on each segment, from which a line of pressure for the groin arch was drawn. No effort was made to apply the elastic theory to the groins.

Having a line of pressure, the width of groin band required to resist the thrust could be determined. At the haunches, near the sidewalk piers, this figured width of groin band was such that it was regarded as improbable that the material would so adjust itself that the maximum stress along the line of the groin would be satisfactory. Compression reinforcement was introduced, therefore, at these haunches.

It will be seen that the problem did not lend itself to complete scientific analysis. Theory offered only a fair guide as to the conditions of internal stress, and it was necessary to make many of the determinations with but little aid from mathematics. In the early stages of the study of this problem it became apparent that any refinement of theory was unjustifiable and possibly misleading because of the probable influence of variations in the unknowable factors.

The limiting stress in the concrete was taken as 450 lb. per square inch, but this was not even closely



COURT AVENUE SUBWAY AND CURVED STAIRWAY TO CAPITOL GROUNDS

approached except at points where reinforcement was added. Thus, compression reinforcement was introduced at the haunch of the main arch and in the sidewalk faces of the piers in order to give maximum stresses of 450 lb. in concrete and 7500 lb. in steel.

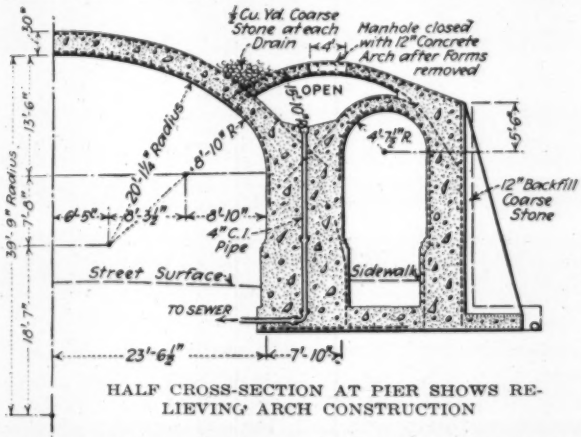
Concrete of the usual proportions of 1:2:4 was used and was made with screened gravel. To insure a smooth working mixture and to avoid staining of the surfaces by moisture, the addition of hydrated lime was specified in the proportion of 8 lb. of lime to each sack of cement. No other waterproofing was specified, except that joints between the work of two shifts were to be coated with elaterite to a depth of 4 in. from the back of the wall as precaution against seepage. Exposed surfaces were finished with cement grout and

ARCH FORMS AND CONCRETING PLANT FOR COURT AVENUE SUBWAY

machined with a surfacing tool after removal of forms.

Footings are seated in the firm gravel soil and on hard shale at some places. No foundation piles were used. Slabs extending under the sidewalk to the abutment footings form braces between footings of piers and abutments. All footings are designed for a pressure not over 2½ tons per square foot on the soil.

The architectural design was made originally by the late E. L. Masqueray, the French architect who



HALF CROSS-SECTION AT PIER SHOWS RELIEVING ARCH CONSTRUCTION

had been chief of design of the Louisiana Purchase Exhibition in St. Louis in 1904. After Mr. Masqueray's death the firm of Slifer, Lundie & Abrahamson, architects, St. Paul, Minn., succeeded to his practice, being organized by men who had been closely associated with him. P. E. Stevens, St. Paul, was the consulting engineer. The Koss Construction Co., Des Moines, Iowa, was the contractor. This bridge was completed in 1917 at a cost of about $68,000.

Columbus Channel Improvements Make Progress

Excavation for widening the Scioto River channel for flood protection at Columbus, Ohio, is about 20% completed. Work was retarded by war restrictions, but reasonably good progress has been made, and most operations will speed up as the season advances. About 90% of the required land has been purchased, and some 150 of the 200 buildings in the way of the widening operations have been wrecked. Concreting has proceeded steadily during the winter, as has excavation for retaining walls and bridge foundations. R. H. Simpson is the engineer in charge of channel improvements.

Associated General Contractors Adopt Constructive Program

IMPROVEMENT of contractual relations, encouragement of sound business practices, and coördination of construction interests, are the broad tasks set for accomplishment by the Associated General Contractors of America. Action will be taken through committees supplied with information and data collected by the secretary and a force of clerical assistants and special investigators to be developed as the need arises.

As recently completed and approved by the directors of the association, the program of operations is: (1) To promote better relations between owners and their architects and engineers on the one hand and contractors on the other hand; (2) to improve and maintain standards in the conduct of work; (3) to combat unfair practices; (4) to increase construction efficiency; (5) to support contractors and contractors' associations in efforts to rectify conditions of an unsatisfactory character; (6) to encourage those methods of contracting for work which relieves the contractor of improper risks; (7) to encourage sound business methods tending to raise the standing of contractors in the business world.

Besides the committees having charge of the routine affairs of the association, there are committees on contracts, legislation, labor, publicity and education, associated organizations, building codes, mutual aid, cost accounting, ethics, and safety. The committees named will conduct the professional work of the association. General directions of procedure have been laid down for each of the seven subjects of the program. Particular effort will be made to push the work and items 1 and 6 of the program.

Better relations between owners and contractors are to be established as follows, as the program states: (1) By teaching owners that the association stands for high ideals and that membership guarantees the reputation of the contractor for skill, honesty and responsibility; (2) by securing a more universal adoption of the cost plus sliding scale fee contract, thereby making the contractor a representative or agent of the owner; (3) by persuading contractors that the interests of their clients and of the community are identical with their own, and that a satisfied client is an asset of immeasurable value; (4) by treating employees with justice and liberality and by taking an interest in their welfare. Specific measures recommended are: Reducing lost time of men, schooling foremen, encouraging apprenticeship, and reducing jurisdictional disputes.

Contractual relations will be improved by urging the adoption of the cost plus sliding scale fee contract where practicable; by insisting that full information be given when lump-sum bids are required; by compelling elimination of the usual clauses placing on the contractor all unforeseen risks and the clauses requiring the contractor to deliver a finished project regardless of what the architect or engineer forgot to specify or show, and by studying and possibly working out a practical arrangement for quantity surveys.

Membership and income have reached a volume which guarantees the means for beginning the committee work. Headquarters have been opened at 111 W. Washington St., Chicago, with Secretary G. W. Buchholz in charge.

Maintenance Data on Twenty-Eight Sections of Test Road

Accurate Records Kept by Philadelphia City Show Relative Cost for Various Types—Traffic Census of Road

IN 1913 the City of Philadelphia laid a test road from Byberry to Bensalem, using five general types of construction in 28 sections, which varied in the details of construction and materials. The types were those ordinarily used for suburban highways. During the six years that have elapsed, considerable amounts of money have been expended in repair. It is now possible to get a preliminary idea as to the value of the various types. To make the data available to the public, the city authorities have prepared a detailed report each year of the condition of the road and the traffic on it. The tabulations given herein were compiled from a forthcoming report.

The selection of materials, mixing and application to the road were completely described in *Engineering Record* of Dec. 6, 1913, p. 628. The data were kept in great detail, so that at any time it could be known just what the conditions were. Subsequent records of repairs have also been kept in detail as regards the various sections, but where several kinds of bituminous material were used in the same section the maintenance cost for each is not contained in the above-mentioned report. Many of the sections have recently been repaired, and are reported in good condition.

The original road was of water-bound macadam, and in reconstructing it the old surfacing was preserved as far as possible. Most of the bituminous sections were simply surfacings for this old macadam, which was shaped up sufficiently to make an even foundation. In the case of concrete, brick and Bicomac, which had concrete bases, more disturbance of the water-bound surface was necessary.

Five different general types of construction were used: Mixed bituminous; concrete, generally with a bituminous mat; vitrified brick; bituminous macadam; penetration; and Bicomac laid upon a concrete base. A number of different stretches of each of these types were laid, with the exception of the Bicomac, and various mixtures with both tar and asphaltic cement were used in the mats and surfacings.

In considering the mixed bituminous type, all sections in which the aggregate and bituminous cement were machine mixed are considered under one head. In nearly all cases, trap rock was used for the aggregate. The sections 1, 2, 6, 7, 11, and 12 are described as in fair to good condition, slightly wavy, with longitudinal and transverse cracks in some of them. Table I

TABLE I. COST, MAINTENANCE AND CONDITION OF SECTIONS OF BYBERRY AND BENSALEM TEST ROAD, PHILADELPHIA, PENN.

			Surfacing				Maintenance			
Section	Date Constructed	Type of Foundation	Type	Thickness Inches	Cost per Sq.Yd.	Total Sq.Yd.	Total Sq.Yd.	Total Cost	Average Cost per Sq.Yd. per Yr.	Remarks
1	7/12	Old macadam	Amiesite	2	$0.7573	6578	6059	$6858.05	0.1738	Good condition
2	11/12	Old macadam	*Mixed bituminous	2	1.6118	1778	63	58.11	0.0055	Losing contour
3	11/12	.....	5-in. concrete	Bit. carpet	1.14.2	533.3	1315.6	838.83	0.2621	Good condition
4	12/12	4-in. concrete	Vitrified brick	5	2.6531	444	16.0	29.16	0.0109	Sand cushion and cement grout joint
5	8/13	.....	5-in. cement	Bit. carpet Av.	0.9834	1244	2899.1	2415.39	0.3236	Good condition
6	12/12	Old macadam	Filbertine	2	1.2581	2222	102	168.30	0.0126	Cracked and slightly wavy
7	12/12	Old macadam	Mixed bituminous	2	1.4291	2222	9	7.92	0.00059	Cracked and slightly wavy
8	12/12	4-in. concrete	Vitrified brick	5	2.6032	533	0.0	0.0	0.0	Good condition
9	8/13	.....	5-in. cconcrete	Bit. carpet Av.	1.2101	2933	2101	1771.07	0.1006	Fair condition
10	7/13	4-in. concrete	Brick	5	2.5532	533	0	0.0	0.0	Fair condtion
11	8/13	Old macadam	Mixed bituminous	2	1.2836	1067	188	115.10	0.0179	Good condition
12	8/13	Old macadam	Mixed bituminous	2	1.6083	1067	256	160.49	0.0251	Disintegration indicated
13	8/13	4-in. concrete	Vit. brick	5	2.8443	622	0	0.0	0.0	Good condition
14	8/13	.....	5-in. concrete	Bit. carpet	1.2505	978	2093.1	1744.92	0.2973	Good condition
15	8/13	4-in. concrete	Vit. brick	5	2.6401	533	89	68.70	0.0215	Cracked; good condition
16	9/13	Old macadam	Bit. penetration	3	0.8866	1067	1491	214.81	0.0335	Good condition
17	9/13	Old macadam	Bit. penetration	3	1.0599	640	1219	334.59	0.1307	Fair condition
18	9/13	4-in. concrete	Brick	5	2.8670	427	0	0.0	0.0	Good condition
19	9/13	Old macadam	Tarvia penetration*	3	1.0577	1067	1623.75	277.20	0.0433	Good condition
20	9/13	Old macadam	Texaco asphalt penetration	3	1.0154	1067	2683.93	778.70	0.1216	Fair condition
21	9/13	Old macadam	Bit. penetration	3	1.0780	1067	1892.84	509.58	0.0796	Wavy and a few wearouts
22	9/13	Old macadam	Asphalt penetration	3	1.2150	1067	1269	152.71	0.0238	Wavy and a few wearouts
23	9/13	Old macadam	Asphalt penetration	3	1.1511	1067	1789.43	161.81	0.0252	Slightly wavy
24	9/13	Old macadam	Asphalt penetration	3	1.2997	1067	1355.4	94.16	0.0147	Fair condition; slightly wavy
25	5/13	4-in. concrete	Bicomac	3	1.8671	978	461.0	177.72	0.0303	Signs of disintegration
26	5/13	4-in. concrete	Brick	5	2.8834	1004	0.0	0.0	0.0	Good condition

* Topeka specifications

TABLE II. TRAFFIC CENSUS, TAKEN BETWEEN HOURS OF 5 A.M. AND 9 P.M.

SUMMER

Character of Traffic	Friday					Saturday					Sunday					Monday				
	1914	1915	1916	1917	1918	1914	1915	1916	1917	1918	1914	1915	1916	1917	1918	1914	1915	1916	1917	1918
1. Horse without vehicle	9	0	0	0	2	2	0	0	0	2	1	0	0	0	1	4	0	0	0	15
2. Horse vehicle, light	32	13	20	7	41	51	27	15	15	30	56	73	15	7	41	33	29	17	7	25
3. Horse vehicle, heavy	15	30	23	5	6	5	37	12	9	8	0	6	2	2	2	5	8	20	12	2
4. Two-horse vehicle, light	3	0	0	0	15	5	0	3	0	6	1	0	0	0	10	6	0	0	0	2
5. Two-horse vehicle, heavy	22	50	37	18	8	9	37	27	18	7	0	12	0	0	1	15	7	34	15	1
6. Three-horse vehicle	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
7. Motorcycles and bicycles	39	22	40	47	136	217	41	149	85	209	155	338	474	449	408	31	81	64	52	175
8. Two-passenger motor cars	36	125	133	102	154	51	192	198	123	181	81	417	211	192	248	24	87	13	82	197
9. Touring motor cars	134	238	353	453	903	371	403	698	580	1567	480	883	989	1774	2766	103	355	304	509	939
10. Light freight motor trucks	2	8	10	27	106	1	11	14	47	87	0	2	9	24	63	1	8	21	53	69
11. Medium freight motor trucks	12	10	24	16	143	6	14	14	26	113	4	21	10	7	200	4	7	21	14	94
12. Heavy freight motor trucks	3	14	24	48	152	7	19	19	36	162	1	4	3	19	160	9	11	26	48	207
13. Miscellaneous heavy traffic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total—Summer	307	510	664	723	1667	725	781	1151	939	2372	779	1756	1713	2474	3900	235	593	520	792	1721
Total—Autumn	225	461	827	....	1667	425	579	1047	....	2217	718	840	2006	....	....	272	347	759	....	1122
Total—Winter	333	563	499	367	....	370	493	1263	586	....	109	1746	657	619	....	142	395	431	53	
Total—Spring	....	279	665	502	1243	....	181	880	826	2166	....	80	1649	1479	4099	....	233	692	400	1541

gives information as to the general construction and maintenance costs of the various sections. The highest cost of maintenance was on Sec. 1, which was about 17c. per square yard per year, while the lowest was Sec. 2, which was about 5 mills. The average cost per square yard per year was about 4c. If Sec. 1, which is abnormally high as compared with the others, be omitted, the cost per square yard per year averages about 1c.

Concrete with Various Carpets

Concrete was used for paving four sections, 3, 5, 9 and 14. Of these, sections 3, 5 and 14—the last named of which was of the Hasson type—received originally bituminous mats. These mats failed badly, and were replaced in each case in 1916, by the use of various methods. In 1918 all sections were resurfaced with 1-in. binder and 1½ in. of top, forming a sheet-asphalt surface. In figuring the yearly maintenance the resurfacings were included. Sec. 9 was constructed with bituminous mats of various kinds, one division being left plain concrete. This section had worn so badly that 860 yd. had to be replaced in 1914, after which a bituminous mat was again applied. The section is reported in good condition. The lowest maintenance cost of the concrete sections per square yard was 10c., while the highest was 32c. The average maintenance cost per square yard per year was 26c. The proportions used for this work were 1:3:6, with the exception of the Hasson type, which was grouted with 1:2 grout. It would seem that where very thin mats are used it is almost impossible to make them adhere to the concrete surface.

Vitrified Brick

Vitrified brick was used on seven sections, 4, 8, 10, 13, 15, 18 and 26. A 4-in. concrete base was used with sand-cushion and grouted-brick top. Very little maintenance was given to these sections during the six years. Only two sections received any repairs at all—No. 4, with 1c., and No. 15, with 2c. per square yard per year. There were longitudinal and transverse cracks in many of the sections, and the repairs consisted of filling these with Tarvia and torpedo gravel.

Bituminous Macadam, Penetration

Bituminous penetration 3 in. thick was used upon eight sections, 16, 17, 19, 20, 21, 22, 23 and 24. Many kinds of bituminous cement were used, and the repairs consisted of some patching of holes and a seal coat applied in 1916. The condition is described as generally good, some sections being slightly wavy, while others have longitudinal and transverse cracks. In some cases the edges are ravelling. The lowest maintenance was for Sec. 24 at 1.5c., and the highest on Sec. 17 at 13c. per square yard per year. The average for the entire eight sections was 5.9c. per square yard per year.

Sec. 26, known as a Bicomac pavement, was laid upon a 4-in. concrete base and was applied by a cold-mix method, using emulsified asphalt. The stone was thoroughly coated with the asphaltic emulsion, the sand and cement were mixed and added to the coated stone, and the whole was thoroughly saturated again with the solution. The surface is reported to be wavy and shows signs of disintegrating. The average cost of maintenance per square yard per year was about 3c.

Table II shows a traffic census, taken between the hours of 5 p.m. and 9 p.m., in the summer, autumn, winter and spring, and on Friday, Saturday, Sunday and Monday, for the years, 1914, 1915, 1916, 1917 and 1918. Large increases in the number of light and heavy motor trucks will be noted. The traffic was the same over all the sections.

Professional Consciousness Must Be Developed Through Service

PRIMARILY, an engineer is "a man whose life is devoted to promoting and planning things that actually happen," according to S. M. Swaab, who recently addressed the Philadelphia Association of Members of the American Society of Civil Engineers. The engineer is "slowly but surely assuming his rightful position in the world," he continued, and stated that the relation which professional engineers bear to modern business and the rate of their compensation will depend upon the degree to which they individually develop a professional consciousness through service and succeed in securing their share of the proceeds of their work. The following short abstracts are taken from his development of this idea.

In his financial relations to the public, the engineer should be over-scrupulous, so that it shall never be said of him that he, like so many others engaged in business and in professional pursuits, has developed a sordid money-sense; but he should undoubtedly have a well balanced commercial vision of the fitness of things and the relation of the technical effort employed to the results and benefits accruing therefrom. There is no question of the fact that as engineers are usually recruited from the ranks of those who are required to maintain themselves by their individual efforts they should see to it that early in life they get on the right track. Ninety per cent., or probably more, of all engineers are employees rather than employers, and for the reason that the engineer usually is entrusted with the conduct of work which primarily is, or at least is intended to be, revenue producing, he, like any other laborer, to use an oft-quoted expression, is worthy of his hire.

In case the profit incident to his work is shared by others, which is usual in engineering works, he should certainly know sufficient of the gentle art of securing for himself a liberal share of the proceeds of his work—not to let the other fellow get all of it—and he should recognize that it is worse than foolish to use his God-given vision, his brains and his professional attainments solely for the aggrandizement of others and entirely for their financial benefit.

He should, therefore, use every honorable means to secure for himself an adequate share of the results of his ingenuity, not alone for the actual effort involved, but also sufficient to compensate him for his "knowing how." Working for a weekly or monthly, or, in fact, any fixed stipend should be discouraged, as is the practice of that master of organization, Charles M. Schwab, whose method is to allow every man to participate in the profits derived from any piece of work in which he may be directly interested.

Evidently, the relations of the engineer and the public are reciprocal, and unquestionably, and above all and all of the time, *our first duty is service;* service without stint, service to the utmost, and this means the best that is in us. Second, the public owes us adequate recognition and remuneration commensurate with our efforts. But first, foremost and above all else, the first duty of the engineer is service.

Grit Chamber and Fine Screens for Part of New York Sewage

First Plant to Treat Sewage from Manhattan Borough—Eductors Clean Grit Chambers—Two 14-Foot Riensch-Wurl Screens

BY CHARLES E. GREGORY
Engineer of Drainage and Sewage Disposal, Borough of Manhattan, New York City

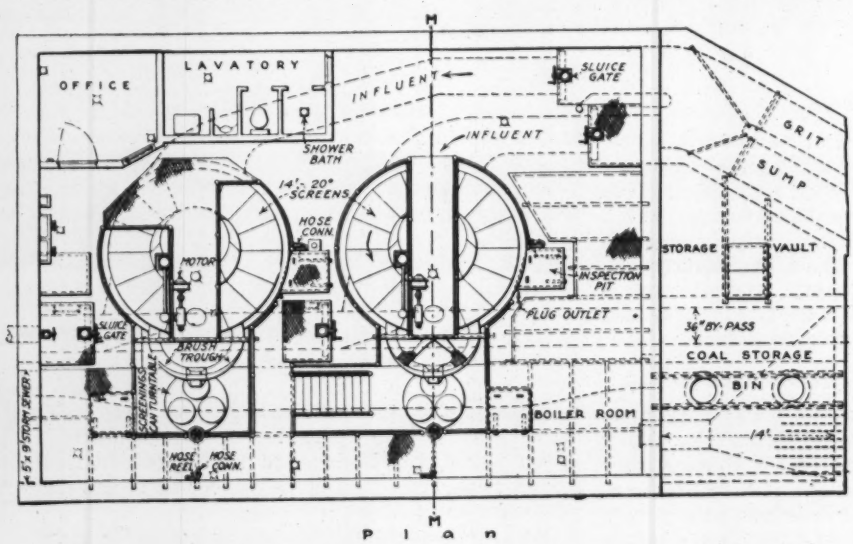
A GRIT chamber and a pair of fine screens of the revolving-disk type, recently put in operation at the foot of Dyckman St., is the first sewage-treatment plant to be built in the Borough of Manhattan, New York City. It is the first step in a comprehensive plan to control pollution of the waters of New York harbor, based on studies begun in 1903. The large volume of harbor waters, with tidal currents and upland fresh-water flow, affords favorable conditions for disposing by dilution of the 500,000,000 gal. of sewage a day produced by New York City, but because of the rapidly increasing ratio of sewage to diluting water serious nuisance exists in various parts of the harbor.

The Dyckman St. sewer, like others in New York City, is a combined sewer. It serves an area of 345 acres in the upper part of the island, of which area about 17% has been built up with apartment houses. The present maximum dry-weather flow is about 3.5 sec.-ft. As originally built, the sewer, of the brick-arch type, was 7 ft. wide by 5 ft. high, and it discharged into the Hudson River at the edge of the high-water shore line. The accumulation of sludge along the shore caused a nuisance to sight and smell.

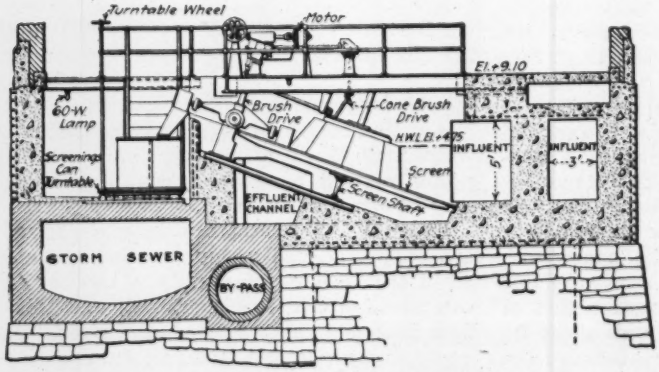
The dry-weather flow is diverted from the Dyckman St. sewer at a point about 1100 ft. above the outlet and carried through a sewer of flatter grade delivering the sewage at an elevation sufficiently above high tide to pass it through the treatment plant and a submerged outlet and discharge it by gravity on the river bottom about 100 ft. from the screen house in more than 40 ft. of water. The bottom of the river at this point is rock and is swept by strong tidal currents.

Outside the screen house provision is made for guiding the flow from the diverting sewer either into a bypass or into the grit chamber from which it passes to the screens. No regulator is employed at the upper end of the diversion sewer, as any excess quantity reaching the screens will flow over adjustable stop planks into the bypass or back into the storm sewer as soon as a maximum depth is reached on the screens. In this way reliable regulation is secured automatically, without making use of a device with moving parts, or loss of head.

The grit chamber is of the two-story type, and is equipped with Otterson eductors for cleaning. It has not been in operation long enough to furnish any reliable data, except to demonstrate the practicability of the cleaning device, which works under the head of water in the local water mains. The diaphragm separating the chamber into two stories serves to maintain a velocity in the upper chamber sufficient to carry over all the lighter organic matter, even though the lower chamber is empty. This would be impossible with a one-chamber structure. The present installation of screens has an estimated capacity of about 10,000,000 to 12,000,000 gal., which is one-half of what is expected to be the ultimate need of this outlet, and the plant has been designed to permit future extension. Two screens of the Riensch-Wurl disk type, each 14 ft. in diameter, set at an inclination of 20° with the horizontal, have been installed. They have an assumed daily capacity of from 5,000,000 to 6,000,000 gal. each, and are inclosed in a neat brick building about 48 ft. long and 35 ft. wide. The screenings are brushed from the disks into galvanized metal cans which rest on a platform; the latter is revolved as each can is filled, to bring the next can in place to receive the screenings. The cans are removed

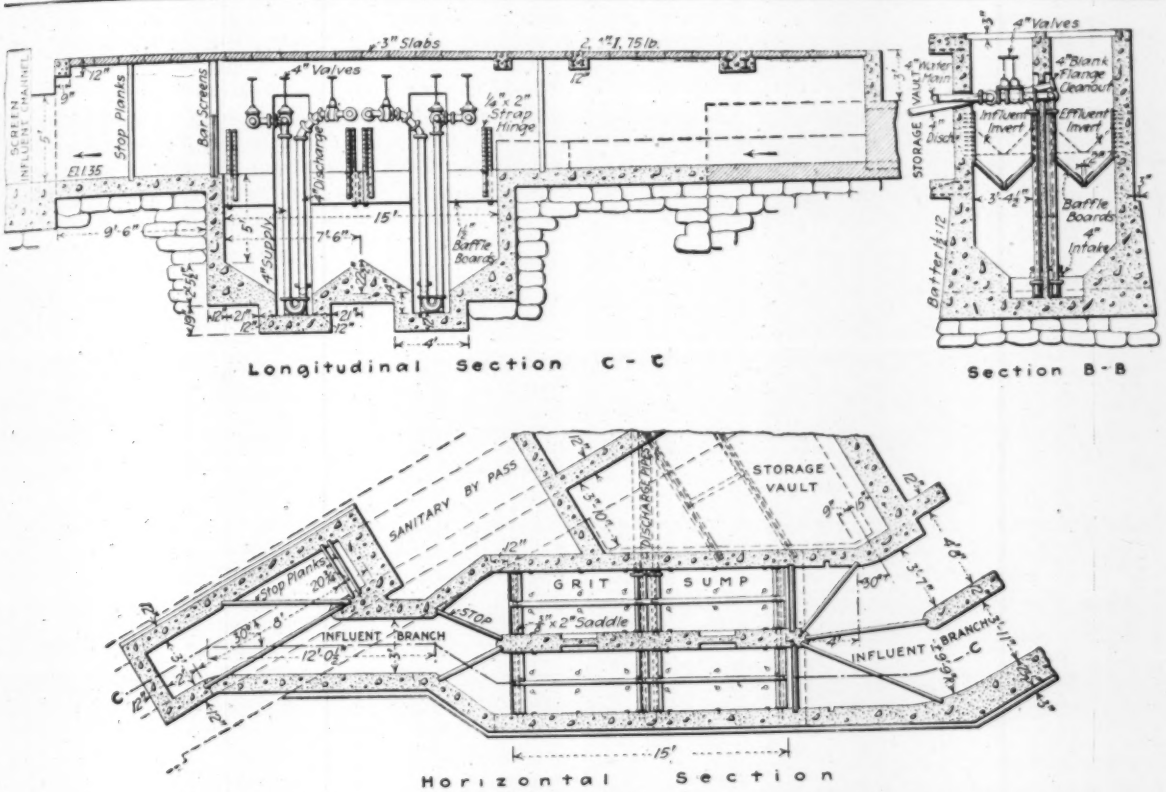


Plan



Section M-M

THE GRIT CHAMBER IS FITTED WITH EDUCTORS



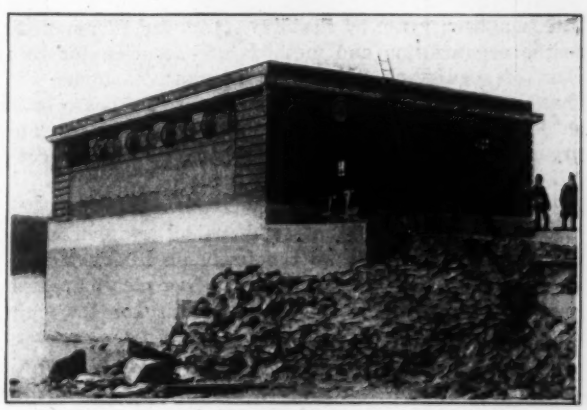
SECTION THROUGH SCREEN HOUSE OF NEW YORK SEWAGE-TREATMENT PLANT

from the revolving platform by an electric hoist which operates along a 10-in. I-beam upon which the cans may be transported to either the shore or water side of the building for loading either into boats or trucks for removal to a suitable dump, reduction plant or incinerator. At present, and until other plants have been developed, screenings are taken to the nearest street-cleaning dump and disposed of with road basin detritus and garbage.

Each screen is operated by a 2½-hp. motor. The screen disk plates are manganese bronze. The contractor was required to demonstrate the screen with apertures of various widths, the smallest being $\frac{3}{64}$ in. wide and 2 in. long. Piping for spraying the screens with hot water or other cleansing or antiseptic solutions is provided. The floors and walls of the building are finished smooth with rounded corners, so they can be washed down with streams from hoze nozzles. This especially applies to those parts liable to collect sediment or spatter from the screenings. The influent and effluent channels are provided with sluice gates for controlling the flow. One corner of the building is partitioned off into a small office and wash-room. The windows are all about 10 ft. above ground and are screened to exclude flies. Additional light is provided through skylights in the roof.

The contractor was required to operate the plant 30 days to demonstrate its mechanical perfection and determine which size of opening was best fitted to the local conditions. The smallest opening tried was $\frac{3}{64}$ in. wide and 2 in. long, and collected 50 % more screenings than the $\frac{4}{64}$-in. opening. The larger openings were not tried, for obvious reasons. The loss of head on the $\frac{3}{64}$-in. opening, when 2,000,000 gal. of sewage were flowing through about 25% of the available area of one screen, varied between 1 and 2 in. When a less area was used there was a decided increase in loss of head as well as a decrease in the quantity of screenings removed.

The sewage at this outlet is considerably weaker than typical Manhattan sewage. Samples taken at various times show that it averages about 150 p.p.m. suspended



DYCKMAN STREET SEWAGE SCREENING HOUSE

solids. The screen plates with smaller openings removed from 21 to 28 cu.ft. of drained screenings in eight hours. The estimated flow for the corresponding period varied from 520,000 to 1,000,000 gal. While no records other than of the quantity of screenings removed were kept to determine accurately the percentage of purification, a comparison of the screenings removed with the

usual total suspended solids in the sewage shows a removal of from 15 to 40% and an average of 32%, which indicates that the expected 20% average removal of suspended solids will be more than accomplished. Often the forenoon rate of removal was double that of the afternoon.

A final decision as to the efficiency of the screen will depend upon results obtained during a considerable period of operation, and it would not be without precedent if some materially different and more reliable results were obtained through such an operation.

On account of war conditions, the contract price for the plant was materially more than was anticipated. The total cost, including grit chambers and building with deep foundations below tidewater, was $77,000.

Maintain Earth Roads by Patrol Contracts in Kansas

State Highway Department Has General Supervision but Lacks Power of Initiation—Machinery Counteracts Labor Shortage

HIGHWAY maintenance by the patrol contract system has been used heretofore in Kansas with what have been considered very satisfactory results, but last year, on account of the labor shortage due to the war, it is said to have failed in many places, the farmers refusing to leave their own work to drag the roads. The county engineers, who work under the supervision of the State Highway Commission, have been forced to adopt various forms of labor-saving machinery and take over the maintenance of long stretches of road with their own gangs. While the state department has general control of the work, it has little power of initiation, and therefore has to wait for action of the people, instead of doing constructive planning.

Maintenance in Kansas consists mainly in the dragging and light grading of earth and gravel roads, since hard-surface construction exists on but a very small part of the highway system. Special attention, therefore, has been given by the State Highway Commission to the organization and methods of execution for this class of road work. While maintenance is under the charge of the county and township authorities, it is subject to supervision of the commission, whose approval of plans is required, and which has indirect control of the county and township funds.

For maintenance of earth roads the commission has arranged a road-dragging and patrol system. The county commissioners and the township highway commissioners award contracts to local drag men or patrolmen, covering specific sections of county or township roads, these sections, varying in length from three to seven miles. As far as possible, the contracts are drawn for one year. Besides dragging the road after each rain, the patrolman is instructed to take care of other maintenance matters, including minor repairs on bridges and culverts. The larger repair and construction jobs are handled by the county engineer or the township road overseer.

Printed instructions for the drag men and patrolmen are not issued by the highway commission, as conditions vary so widely in different parts of the state. County engineers give their own instructions, which usually provide that the roads shall be dragged after every rain that is heavy enough to allow the earth to pack after dragging. The patrolman is furnished usually with a steel drag, a slip scraper and a shovel. Any other tools he may find necessary he must furnish for himself.

Standard forms of contract are employed by which the drag contractor agrees to "drag and care for" a specific section of road for a specific period of time; also to provide a substitute when necessary. He agrees to do the dragging at such time and manner as required by the county engineer (or the township overseer) and to report this work promptly on cards furnished for the purpose. He must also keep informed of the condition of the road and report promptly any damage to culverts, bridges or grade.

The payment varies in different parts of the state but averages from 50 to 75c. per mile for a single round trip, $1 to $1.25 for a double round trip and $1.50 to $2 for a triple round trip. For repairing culverts or bridges and for any other service ordered the pay per hour is about 35c. for each man and 60c. for man and team. The postcard for daily report shows the date and section, the number and location of miles dragged once or twice, and the hours and location of extra work for men and men with teams. The claim or voucher made out each month is a sheet showing this daily information and is sworn to by the contractor.

Machinery Meets Labor Shortage

Labor supply is now the greatest problem encountered but the local patrol system is reported to have worked satisfactorily until last year, when several counties found it almost impossible to get patrol work done, as help was so scarce that farmers did not care to neglect their own work to handle patrol contracts. The engineers in some of these counties arranged for dragging long sections of road by motor trucks or light tractors, thus avoiding the use of teams. In some instances, where the soil is of such a character that to drag in this manner would prevent covering the road at the proper time after the rain, it has been found advisable to use a road planer or a light grader drawn by a tractor or truck, which will smooth up the road. If a little moisture is present the earth will usually compact into a good surface for traffic.

Many counties and townships found it impossible to obtain sufficient teams for grading their earth roads and purchased tractors and heavy motor trucks for the work. They found this plan much more satisfactory. One county engineer, having 1000 miles of road of which 126 are county highways, plans to keep a two-man gang on the earth roads continually with a tractor, grade and bunkhouse on a motor truck.

Where heavy motor-truck traffic is carried on gravel and earth roads, dragging is usually insufficient to maintain a good condition, and light graders are sometimes used. Under ordinary traffic conditions, however, dragging is the only type of maintenance that has been found satisfactory for such roads. Until such time as hard surfacing can be applied to the main traveled highways, dragging must be relied upon to maintain the roads. Oil has been employed on some roads having heavy motor-truck traffic near cities, but the engineers state that this has not proved satisfactory.

The Kansas State Highway Commission is composed of three members, of whom the Governor, Arthur Capper, is chairman. M. W. Watson is acting state highway engineer, during the absence of W. S. Gearhart on military service. F. W. Epps is bridge engineer.

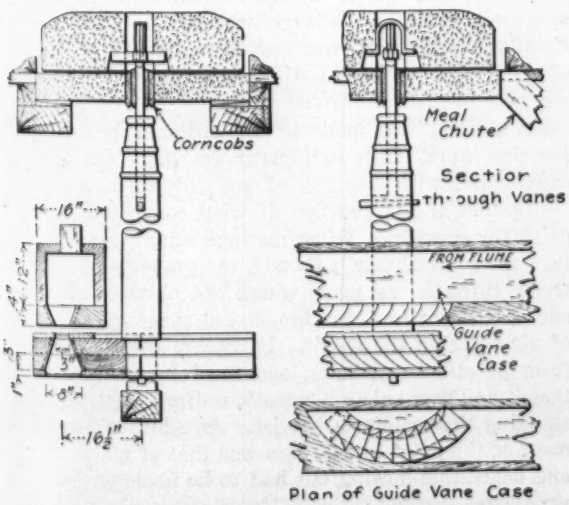
Old Southern Mill Has Curious Horizontal Wheel

Such Grist Mills Though Inefficient Have Value in These Days of Railway Freight Congestion and Grain Shortage

By H. K. Higgins
Copperhill, Tenn.

THERE are scattered throughout the United States a number of old grist mills which in spite of advances of civilization, with its centralization of manufacture and production, still efficiently serve local communities. In a recent trip through the mountains of northern Georgia the writer came across one such mill which has a curious horizontal waterwheel of modern design though primitive construction. Its details seem to warrant description.

The essential part of a grist mill is the two millstones with their characteristic grooves on the grinding surface. These can be of several varieties of stone, natural or artificial. Usually some variety of local stone is available in any country where water power is available. The stones in this case appear to be of a variety of granite and give evidence of having been fully effective. The upper or moving stone is carried by the vertical shaft through two yokes at right angles, let into four notches cut into the lower surface of the stone. The lower stone, which is much thinner, is carried on wedges on heavy beams. Both stones have an axial hole of about 6-in. diameter. The shaft where it passes through the lower stone is "babbitted" with corncobs, an effective if somewhat crude device. This iron shaft or gudgeon is attached to the wooden vertical shaft by a T-shaped head which fits into a long slot in the shaft and is secured by oak fillers and iron bands. A taper key below it provides means for adjustment.



PRIMITIVE HORIZONTAL WATERWHEEL BUILT IN GEORGIA HALF A CENTURY AGO

The casing around the stone is not shown, nor the feed hopper and its shaking valve or feeder. The latter is a grooved plank hung on leather straps and jarred by a multiple cone on a short vertical extension of the shaft. Of course this mill does not bolt the flour, but grinds as fine as desired. A bolting device could easily be added.

The waterwheel is a most ingenious adaptation of the turbine principle all worked out in wood (oak) with the single exception of the wheel and guide vanes, which are evidently iron (not steel) and show little evidence of wear or corrosion. No one knows just how old they are, but the rest of the wheel has been in use 40 years at least, and so have the vanes. The wheel proper is built up of two thicknesses of 3-in. and two of 1-in. planks, pinned, nailed and probably dovetailed together. The vanes or buckets are in grooves and are retained by the outer layers of plank. The vanes curve about 1½ in. and the chord sets about 45° from the plane of the wheel. The water is led to the wheel through a guide-vane box made from two timbers about 4 x 12 x 16 in. The 12-in. timber is hollowed out and inverted over the 4-in., which carries the guide vanes set radially in grooves in a tapered slot. The wheel is about 33 in. in diameter to center of buckets. These taper from about 3 in. at entrance to 8 in. at exit. There is no draft tube—the wheel discharges freely a few inches above tail water.

The dam which serves this mill is about 12 ft. high, stone faced and earth backed. The flume is about 3 ft. or less wide, 10 ft. high, 20 ft. long, and forms the waste spillway as well as the flume proper. The stream is a brook in mountainous country some 1700 ft. above sea level. There is very little water storage; the streams carry heavy burdens of silt and soon fill the ponds.

While such a mill leaves something of efficiency to be desired, the power cost is nil, cost of attendance not excessive, and interest on capital about the only overhead. The capacity is about three bushels of corn per hour, considerably more than enough to keep the tributary community in bread. These mills are occasionally called on to grind barley and rye, making a so-called graham flour, much esteemed as a variant from the customary corn flour. The white variety of corn is almost universally grown in this region. This produces a nearly white meal or flour, making a bread at once palatable and much more wholesome than the starch flour we all know so well.

Such mills have to a great extent come to be considered obsolete for some years past, or since the advent of railroads with easy access of white flour from midwestern mills. They have therefore been allowed to fall into bad order. The experiences of recent winters, with their freight congestions and indiscriminate embargoes, indicate the wisdom of putting these local facilities, so far as practicable, into condition for further use. To some extent this is being done. It is of course also true that in localities remote from railways such mills are and always have been in constant use. Even a few miles over mountain roads means a condition in which such a mill can thrive. There are many unutilized streams all over our country; little capital is required; most communities have plenty of men available for millers; the work is far from arduous. There

should be such mills at ten-mile intervals all over the well watered part of the country. Such a mill with suitable cornfields around it effectually safeguards its community against starvation, even with the railroads worse congested than they have been recently, if that be possible.

Spraying Paint on Corrugated Steel Before Shipment

Speed Requirement and Necessity for Rapid Drying, to Allow Handling, Result in New Methods of Applying Structural Paint

By Thomas M. Wheat

Chief of Engineering Branch, Supplies Section, Division of Military Aëronautics, New York City

WHEN the supply section of the Signal Corps was confronted with the necessity for painting a large quantity of corrugated-steel sheets in the shortest possible time, for use on airplane hangars in this country and overseas, unique erection conditions made it necessary to omit the application of a coat of paint in the field. This called for extreme care in painting and packing the sheets in the shop. Hand painting required a large amount of labor, much floor space, and handling of wet sheets. Machine painting was not practicable, on account of the corrugations, and the painting could not be done before corrugating because of the damage done to the paint by the corrugating rolls.

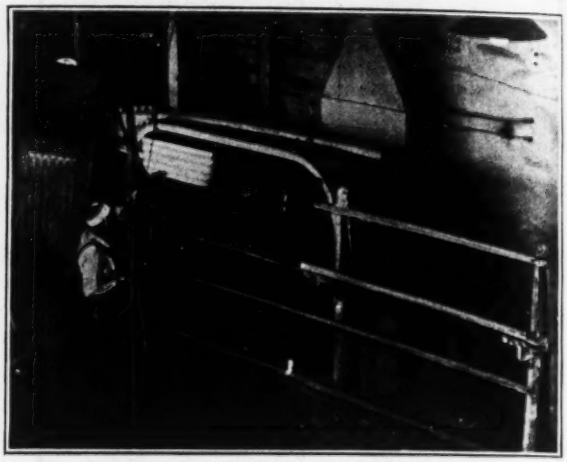
The problem was solved by the use of spraying. Figures are given to show the average surfaces covered per gallon.

This project soon developed into something entirely new. Instead of the finely atomized, delicate jet used on filing cases and such articles, this operation called for a jet 14 in. wide carrying enough actual paint to give a fair protecting coat. The metal paint containers ordinarily used, for example, have a capacity of something like 13 gal., and at the rate of operation maintained these had to be refilled about every hour. This early brought about the purchase of a double set of apparatus—containers, spray guns, hose, etc. This reserve set proved very useful in case of accident, as the layout was such that a shutdown on one gun threw two crews out of action, or about 10 men.

These containers were later abandoned, with the attendant system of air pressures, and there was substituted a gravity feed from barrels on an overhead scaffold.

The sheets required a priming coat of red lead, and this was put on by means of roller machines, before the corrugating was done. Corrugation and fabrication were then completed, and the sheets were brought to the spray operation. Here they were to receive a coat of gray on one side and a coat of green on the other. Hoods were built on the floor, and racks in front of them, for the sheets. Operators wearing gas masks stood before them and sprayed the sheets as shown in the illustration.

The gas masks were necessary at first on account of the peculiar and penetrating odor of the paint. One side of the sheet having been sprayed, the sheet was shoved along the rack to the next hood, facing the opposite direction, where a second operator sprayed the other side. The operation was then completed by hanging the sheet on a traveling chain, by which it was taken through a drying oven. Incidentally, it was discovered that the workman's hands in handling left no mark on freshly painted sheets if his hands were encased in gloves having a surface of emery cloth on the side coming in contact with the paint.



PAINTING CORRUGATED STEEL SHEETS BY SPRAYING

The hoods, as supplied by the manufacturer, were equipped with a 10-in. blade fan at the back, this being adequate for the removal of ordinary quantities of fumes and escaping spray. Not only were these fans inadequate for taking care of the volume of matter to be removed in this case, but quickly became coated with paint and were thus rendered still less effective.

This difficulty was overcome by the installation of an induced draft system by which a 20-hp. motor forced air through a 6-in. pipe into a 36-in. flue from each pair of hoods. The 6-in. pipe was contracted to a 4-in. nozzle in the flue, and the force was enough to remove the spray and fumes, discharging into the open air through a vent in the roof. Several months later it was discovered that a large area of the roof in the vicinity of this vent was covered with several inches of paint. Conduits and gutters were thoroughly clogged —a new form of industrial waste.

An attempt was made to use ordinary brush paint for this work, with indifferent results. The trouble experienced with clogging of apparatus led to the investigation of the question of what constitutes a good paint for spraying. Of prime importance was the feature of "squirtability"; that is, the property of flowing freely through the guns, where the paint is atomized and spread out in a fine fan-shaped spray by a current of air entering the nozzle. It reaches the sheet in the form of minute globules, and must be so constituted that it will flow out in a smooth, uniform coat, notwithstanding the cooling in the jet. An additional requirement of the paint in this case was that of quick drying, and hence this flowing out had to be accomplished in a very brief period.

The specifications called for a paint that would dry

in six hours, and the plan was to force the drying to an hour and a half in an oven at a temperature of 160° F. A paint that will fulfill the ordinary specification of drying "to touch" in a given number of hours is by no means necessarily dry enough to *handle*. Sheets that came from the oven not dry enough to handle and pack directly were stacked on the floor until dry and hard, and this not only took up valuable labor and floor space, but also occasioned unavoidable damage to the paint itself.

The addition of drier was inadvisable beyond a certain point, of course, and it was some time before attention was given to the air-jet agitator used to stir the paint in the mixing barrels and reservoirs. The elimination of these constantly flowing streams of air and the substitution of hand stirring for them led to very satisfactory results in drying. The theory of it seems to be that the jets effected greater evaporation and drove off the lighter, more volatile, drier and thinner liquids.

A point of great interest was the question of how many square feet of metal could be covered with one gallon of paint. During six months' observation at the plant of the Berger Manufacturing Co., Canton, Ohio, it was found that this figure varied greatly. This variation depended, apparently, upon the color of the paint, its specific gravity, the operator, the apparatus and even the weather. The average for a "battleship" gray is 350 sq.ft. per gallon and for an "invisible" green 375 sq.ft. per gallon.

These figures include all the paint actually brought on the premises. Probably 10% of all the paint bought and paid for was wasted. This considerable item was countenanced in the interest of speed, which was a matter of greatest importance. Numerous suggestions were offered for eliminating or reducing this loss, but it certainly never went below 6%. The figures given above are for square feet of sheets in the flat. The Truscon Steel Co., at Youngstown, Ohio, installed a system of automatic spraying, and this may have reduced the loss of paint.

So far as the writer knows, no data are available as to the protective qualities of a paint covering that has been sprayed on. If this structural value is satisfactory the speed of application makes it evident that this method is vastly superior to the ordinary method of hand painting, particularly for the shop coat on structural steel.

Typhoid in the Expeditionary Forces of the American Army

Began to Appear During Offensive Early in November, Due to Extraordinary Exposure—Death Rate Not Unusual

BY GEORGE A. SOPER
Major, Sanitary Corps, United States Army, Office of the Surgeon General, Washington, D. C.

AFTER having been practically eliminated as a cause of disability in the United States Army, typhoid fever has recently made its appearance in the Expeditionary Forces under circumstances of broad, instructive interest. How the typhoid rate was reduced from its high place a generation ago nearly to zero and kept there during the mobilization of our troops in the present war, need not be repeated here. In the permanent American camps, sanitation, particularly as regards water-supplies and sewage disposal, together with vaccination, had eliminated the disease as a cause of anxiety. This dual method of control had proved entirely satisfactory. Its results may be said to represent an ideal toward which American cities and towns should aspire.

Army experience before and since the outbreak in France shows that these two procedures of sanitation and administration are necessary and sufficient in order to control typhoid.

Tyhpoid began to appear in the Expeditionary Forces during the offensive early in November. When, in the fighting in the Argonne, men became very thirsty, they sometimes disregarded their instructions and drank from forbidden, polluted sources. These men were protected against ordinary exposure to typhoid, but they were not, and could not, be made proof against the mass attacks of the heavily infected water.

The conditions which were encountered in the Argonne advance were repeated with certain variations elsewhere. For example, at Nevers tap water, forbidden for anything but industrial purposes, caused fifty or sixty cases. Much the same is to be said of Joinville (Haute Marne). Contact infection accounted for some of the cases which occurred among the personnel attached to hospitals and for the same reason: The danger was wholly unexpected and the dosage was excessive.

It is curious to observe that the rarity of typhoid contributed materially to its spread. Trusting implicitly to the safety afforded by vaccination, in spite of warnings that it does not afford unlimited protection under all circumstances, the thought of typhoid, the measures to be taken to prevent it, and the clinical recognition of the disease, had been banished from the minds of many medical officers.

The early cases which occurred were, therefore, not always promptly recognized, and the necessary steps to prevent contact infection were not always taken. And after it had begun to spread, the typhoid proved no

CASES OF TYPHOID AND PARATYPHOID IN THE AMERICAN EXPEDITIONARY FORCES, FRANCE

Week Ended	Typhoid		Paratyphoid		Total
	Weekly	Monthly	Weekly	Monthly	Monthly
Oct. 3	17	...	10	..	....
Oct. 10	1	...	4	..	....
Oct. 17	9	...	1	..	....
Oct. 24	7		1		
Oct. 31	5	39	11	27	66
Nov. 7	10	...	11	..	....
Nov. 14	11	...	1	..	....
Nov. 21	24		6		
Nov. 28	32	77	19	37	114
Dec. 5	22	...	10	..	....
Dec. 12	33	...	11	..	....
Dec. 19	62		15		
Dec. 26	45	162	9	45	207
Jan. 2	46	...	6	..	....
Jan. 9	55	...	5	..	....
Jan. 16	63	...	14	..	....
Jan. 23	85		11		
Jan. 30	69	318	12	48	366
Feb. 6	132		20		
Feb. 13	93	225	13	33	258
Total	821	821	190	190	1,011

exception to the rule that epidemics when once started are extremely difficult to stop.

Although there have not been so very many cases in proportion to the great strength of troops employed, the typhoid has been widely distributed in the American Expeditionary Forces. Between Oct. 1 and Feb. 13, the total number of cases of both typhoid and paratyphoid reported was 1011, as shown in detail by the accompanying table. The death rate was not unusual.

The mean strength of the American Expeditionary Forces in France during this period may be taken as 1,833,000.

Cost of Ditches for Reclaiming Idaho Lands

Cultivated Ground Spoiled by Excess Irrigation Water Is Restored by Drainage—Caterpillar Electrically-Driven Excavators Used

By D. W. Cole

Formerly Project Manager, Boise Irrigation Project, United States Reclamation Service, Boise, Idaho

MORE than 120 miles of deep drainage ditches on the Boise irrigation project of the U. S. Reclamation Service have been excavated to remove excess water resulting from irrigation. As a result, excellent crops have been produced from land which five years ago were in swamp, but which formerly had been farms and orchards. Herein are presented some data on the general cost of the work.

This Idaho project includes about 143,000 acres of crop-bearing land, in addition to lower cultivated areas of about 100,000 acres in irrigation districts through which drainage waters must pass to reach the Boise River. About 17,000 acres of productive lands having become waterlogged or affected by seepage, the U. S. Reclamation Service, in coöperation with the irrigation districts, undertook to construct a drainage system for the relief of these lands and of adjoining lands into which the seepage was progressing. This work, begun about five years ago, has been completed. More than 5,000,000 cu.yd. of excavation have been made for 120 miles of drains averaging 9 ft. in depth, with a range of 6 to 12 ft.

More than 1600 structures were required, as these ditches traverse a highly improved farming country. Reinforced-concrete flumes carry the larger irrigation canals across the drains; metal and wood flumes serve for the lateral ditches. Large reinforced-concrete pipes are used as culverts in many places under highways, railways and canals. Numerous railway and tramway bridges were provided, and bridges for highways on nearly all section lines; and bridges of the same class were supplied for many farm crossings.

For determining the subsurface water conditions, numerous test pits and borings were located, and underground water contours were plotted. In conjunction with surface topography, these were employed for locating the drainage ditches for the greatest efficiency in tapping the subsurface waters. The entire area to be drained was practically underlaid with coarse gravel of an indefinite depth below the surface soils, 2 to 4 ft. deep.

Discharge of seepage water from the numerous drains ranges from 1 to 80 sec.-ft., according to the length of the drain and the tributary area. A group of the principal trunk drains discharged during 1916 approximately 224,000 acre-ft. of water, of which about 57% was seepage water, 28% surface run-off from irrigated fields, and 15% storm-water run-off in January and February.

Four electric dragline excavators mounted on caterpillars, with 50-ft. booms and 1¼-yd. buckets, were the principal equipment. They operate on 440-volt alternating current, furnished at less than 1c. per kw.h. from the project's hydro-electric plant in the Boise River. Transmission line service at high voltage was obtained through contract with the Idaho Power Co., the branch lines at low voltage being installed temporarily by Government forces with the progress of each excavator. A central camp with an electric substation, a repair shop, an electric shop and all necessary accessories was maintained during the operation of the four excavators. The machine efficiency of the excavators is exhibited in one of the accompanying tables.

All four machines were operated in 1916, resulting in 2,660,465 cu.yd. of excavation in the total digging time of 17,732 hours, or 150 cu.yd. per hour per machine. With the rated 1¼-yd. capacity of the buckets this shows two buckets per minute as the average working rate of the machines. The material averaged 2 to 5 ft. of top soil with underlying heavy gravel, streaked with hardpan 4 to 8 ft. deep; occassionally a ridge of hard lava rock made blasting necessary.

Careful cost records were kept for each drain and

EFFICIENCY RECORDS OF ELECTRIC DRAGLINE EXCAVATORS ON DRAINAGE DITCH WORK IN IDAHO

A. Two Excavators: Nov. 16, 1913, to May 30, 1915

	Machine No. 1 Hours	Machine No. 1 Per Cent.	Machine No. 2 Hours	Machine No. 2 Per Cent.
Digging	7,642	75	7,533	73
Mechanical repairs	1,371	13	1,536	14
Electrical repairs	467	4	505	5
Moving	404	4	418	4
Power off	77	1	79	1
Blasting	284	3	314	3
Total	10,245	100	10,385	100
Yardage moved	884,222		884,504	

B. Four Excavators for One Year (Each Working Three Shifts Daily Except on Sundays and Holidays)

	Hours	Per Cent
Digging	17,732	51 0
Repairs	2,730	7 8
Moving up	1,486	4 3
Side drains and runways	592	1 7
Blasting	65	0 2
Power off	430	1 2
Sundays and holidays	3,968	11 5
Structures—laying tile	820	2 3
Breakdown	2,522	7 3
General moving	895	2 6
Substation fire	960	2 7
Moving substation	880	2 5
General repairing	1,696	4 9
Total	34,776	100 0
Machine idle (no work)	360	
Grand total—full year, 4 machines, 24-hr. days	35,136	

COST OF DRAINAGE OF NAMPA AND MERIDIAN DRAINAGE DISTRICT

Average depth	10 ft.
Base width	4 to 10 ft.
Slopes	2 to 1
Excavation	2,015,162 cu.yd.
Ditches	224,322 lin.ft.

	Total	Per Lin.Ft.	Per Cu.Yd.	Per Cent of Total
Investigation and surveys	$26,261	$0.116	$0.013	9 2
Excavation	126,751	.567	.063	44 3
Minor structures	43,758	.194	.022	15 4
Major structures	35,193	.157	.017	12 4
Rebuilding laterals destroyed by deep drains	15,231	.068	.008	5 3
Water rights	25,032	.112	.012	8 9
Right of way	12,723	.055	.006	4 5
Totals	$284,950	$1.269	$0.141	100 0

structure separately, and a full report has been compiled showing the length, depth and cubic contents of every drain and the elements of all its accessory structures, with total and unit costs. A tabulated summary with results for one of the three districts is given herewith. The total cost of the work complete was $615,000.

Elimination of Dangerous Road Junction and Its Cost

Deep Rock Cut and Fill Improve Conditions—Traffic Maintained by Sectional Building—Special Drainage System Installed

By Eugene Gedney
Nyack, N. Y.

ELIMINATION of a dangerous junction by the making of a deep rock cut on a connecting road and a deep fill on the main road, and the reduction of the grade of the connecting road from 18 to 10%, were effected on the Short Clove road which connects two highways near Haverstraw, Rockland County, N. Y. Considerable difficulty was experienced in the construction of this road, due to the very hard rock encountered and the trouble produced by numerous springs adjacent to and within the work. Inasmuch as traffic could not be interrupted on the main highway, the deep fill at the

NEW JUNCTION HAS CLEAR VIEW AND FAIR TURN

junction had to be built in sections, so that there would always be a driveway open.

Short Clove road, which joins the main river route No. 3 of the New York State highway system, has a very sharp curve at the point of union. Coupled with this, the clear view was obstructed by a high rock ledge, and in the laying out of the new connection the main idea was to get a reasonably good junction with a fair grade and a clear view, and at minimum cost. After several schemes were discarded, it was decided to raise the grade of the main road approximately 10 ft., moving the junction of the two roads to the south about 75 ft. This created a short plateau 40 ft. wide, afforded an unobstructed view to travelers on both roads, and

SPILLWAY FROM SPRING PASSES INTO CATCHBASIN THROUGH DRY MASONRY WALL

gave those coming from the south sufficient space to turn into the cross road, which was almost impossible before. A photograph of this new junction as constructed is shown.

The connecting road, which is only 1280 ft. long, is partly in rock cut from 5 to 25 ft. deep. Above this rock the geological formation changes to a soft clay and muck pocket about 300 ft. long and 3 to 18 ft. deep. Underlying the clay pocket there is a stratum of fine sand which contains many springs and considerable seepage water from the adjoining mountains. As soon as the clay stratum was cut through, the seepage and spring water began to run freely, at times nearly flooding the cut. The amount of water encountered is evidenced by the fact that one of the springs near the north edge of the roadway supplied at all times sufficient water for the contractor's steam boiler and other equipment.

To make these unstable soil conditions safe for a roadway, a 6-in. pipe underdrain was laid under the north ditch line and about 3 ft. below the pavement line. Under the south ditch line, where the seepage was less, a blind stone drain was placed. To facilitate drainage into these side drains, a sub-base foundation with porous filler, having a width of 20 ft. and a depth of 24 in., was laid for the full length of this unstable section.

Near the point where the road passes into the rock cut, and 60 ft. to the north, is an exceptionally large spring, for which it was necessary to provide drainage. A concrete apron was built down the side of the cut, and this was connected with the spring by a cement grouted cobble gutter, the drainage passing into a catchbasin in the gutter. This apron and catchbasin are shown in an illustration. The catchbasin is of special

construction and is drained across the roadway by means of an 18-in. pipe, connecting with a similar catchbasin on the other side. Into these catchbasins all drainage from above is carried. In one case it was necessary to form a basin for one of the springs in the middle of the road and lay a special drain from it into the catchbasin. From the catchbasin on the south side and passing through the rock cut, a 12-in. pipe underdrain was laid in a trench 2 ft. wide and 3 ft. deep and covered with crushed stone and small rock. The method of laying this drain is shown in a view (see next page). This drained into an open ditch at the far end of the cut.

Another difficulty encountered was the fact that the side slopes of the clay cut were so unstable that after every rain a part would slide in, blocking the ditches and some of the road. As a protection against these slides, the dry masonry wall, shown about the catchbasin, was built on both sides of the cut.

The rock excavation was also a rather difficult part of the job, as it was done in trap rock that was full of fissures. This made drilling very hard, the run of drill per nine-hour day ranging from 6 ft. to a maximum of 20 ft. On account of this, the contractor endeavored to get along with as little drilling as possible, spacing the holes about 6 ft. apart and drilling from 10 to 15 ft. in depth. It was always found necessary to drill lift holes beyond the bench holes. As the holes were spaced rather far apart, the contractor tried to get as much dynamite into them as possible, and for this purpose the holes were sprung by exploding small charges of dynamite at the bottom, thus enlarging their capacity. In this manner 40 to 50 lb. could be used in each hole.

Two Tons of Dynamite Used

The usual blast consisted of one row of four or five bench holes with about three lift holes 15 ft. back from the face. The average amount of rock loosened by one blast was from 200 to 225 cu.yd. It broke up in rather large pieces, many of them as large as a cubic yard, and the removal of these large stones was effected by means of stoneboats on which they were dragged to a point a short distance from the excavation. Data which were collected show that a total of 1600 lin.ft. of drilling was necessary, and that 4400 lb. of dynamite were used to remove approximately 4800 cu.yd. of rock; about 0.33 ft. of drilling and 0.9 lb. of dynamite for each cubic yard removed.

During the making of the fill upon the main road the contract called for keeping the road open for traffic. This fill was 10 ft. deep on the center line of the road and was 50 ft. deep on the east side, a dry masonry toe wall 5 ft. wide and 15 ft. high being built at its foot in order to prevent it from going upon the railroad property at the foot of the slope. This fill was used as a spoil bank. The method followed was to bring the fill even with the old road; then to build half of the fill up to the new grade, using the other half of the road for traffic; then to turn the traffic over the new fill and raise the other side. This method was found feasible, and traffic on the main road was uninterrupted.

The surfacing of the road consisted of a combination of bituminous and water-bound macadam 20 ft. wide, the middle 10 ft. being bituminous macadam, penetration method, while 5 ft. on either side was of water-bound construction. The water-bound macadam was adopted to take care of horse traffic, as it was thought that the other construction would be too slippery on a 10% grade.

CONSTRUCTION COSTS ON SHORT-CLOVE ROAD
NEW YORK STATE HIGHWAY DEPARTMENT

Earth Excavation

Labor		
Superintendent,	50 days at $5.00	$250.00
Foreman,	80 days at $4.00	320.00
Common labor,	660 days at $2.75	1,815.00
Carts,	170 days at $3.50	595.00
Total labor		$2,980.00
Materials, small tools, incidentals		90.00
Cost of removing 4,200 cu.yd		$3,070.00
Cost per cubic yard		$0.73

Rock Excavation

Labor		
Superintendent,	90 days at $5.00	$450.00
Foreman,	10 days at 4.00	40.00
Blacksmith,	60 days at 3.50	210.00
Drill runner,	176 days at 3.50	616.00
Drill helper,	143 days at 2.75	393.25
Total labor		$1,709.25
Materials		512.00
Depreciation of plant, small tools and incidentals		100.00
Total cost of drilling 1,600 lin.ft		$2,321.25
Cost per linear foot		$1.45

BLASTING AND DISPOSAL OF ROCK

(Average haul 500 Feet)

Labor		
Superintendent,	100 days at $5.00	$500.00
Foreman,	80 days at 4.00	320.00
Common labor,	1,100 days at 2.75	3,025.00
Teams,	150 days at 6.50	975.00
Carts,	200 days at 3.50	700.00
Total labor		$5,520.00
Materials and tools		
Dynamite (3000 lb. at 28c. and 1800 lb. at 35c.)		$1,470.00
Blasting caps, wire and incidentals		100.00
Small tools, etc		60.00
Total materials and tools		$1,630.00
Cost of blasting and disposal of 4,800 cu.yd		7,150.00
Cost per cu.yd		$1.49
Total cost of rock excavation		$9,471.25
Cost per cubic yard		$1.97

Macadam Surfacing

Labor		
Superintendent,	15 days at $5.00	$75.00
Foreman,	15 days at 4.00	60.00
Common labor,	55 days at 3.00	165.00
Cart,	5 days at 3.50	17.50
Team,	3 days at 7.00	21.00
Steam roller,	15 days at 15.00	225.00
Incidentals		25.00
Cost of manipulation, 536 cu.yd		$588.50
Cost per cubic yard		$1.10
Materials		
Crushed stone, 850 tons at $2.50		$2,125.00
Tarvia-X binder, 4,740 gal. at 17c		805.80
Tarvia-B cold application (850 gal. at 17c.)		144.50
Filler for bottom course		25.00
Total for 536 cu.yd		$3,100.30
Cost per cubic yard		$5.78
Total cost of macadam per cubic yard		$6.88

On this 0.24 mile of roadway the material excavated amounted to about 9000 cu.yd. Itemized costs of the major items of the work are shown in the accompanying table. The equipment used consisted of one 25-hp. steam boiler, one steam drill, one jackhamer drill and the necessary small tools. The dump wagons, carts, steam roller, sprinkling carts, etc., were hired locally. Crushed stone for the macadam was furnished by the West Nyack quarries, and was hauled eight miles by five-ton motor-trucks. The bituminous material was furnished by the Barrett Co., and the price quoted covers applying. It was hauled about 35 miles in asbestos-covered auto tanks, and delivered at 275° Fahrenheit.

Work was started June, 1917, shut down December, 1917, started again in March, 1918, and completed in August, the working time being approximately 300 days. It was impossible to run the job economically on account of the labor conditions due to the war. The large amount of coal used in drilling was due to the necessity

VITRIFIED TILE DRAIN IS COVERED WITH STONE

of keeping up steam on days when the drill runner did not appear.

The construction was carried on under the Construction Department of the New York State Highway Department, H. E. Breed, first deputy highway commissioner, J. H. Sturdevant, division engineer, and the writer as engineer in charge. Eugene Cavallo, of Haverstraw, N. Y., was the contractor.

Move Equipment and Material for Dam Through Small Tunnel

In Building Dam Everything Had To Go Through 42 x 48-Inch Section of Santa Barbara Water Conduit Then in Service

BUILDING the Gibraltar Dam for the City of Santa Barbara, Calif., involved the unique problem of getting all equipment, materials and supplies through a tunnel four miles long which has a clearance of only 42 x 48 in. The tunnel was built some years ago for the city water-supply. This supply could not be interrupted, so there was always a depth of 12 to 18 in. of water in the tunnel to contend with, not to mention the continuous downpour from the roof in many places. On account of difficulties encountered in driving the tunnel, its alignment is not good. It is lined with concrete for part of its length, the remainder being irregular rock section. The problem of transportation through the tunnel has been effectively worked out, however, and in the first three months of the construction period 15,000 cu.yd. of concrete was poured with but little delay on account of tunnel difficulties.

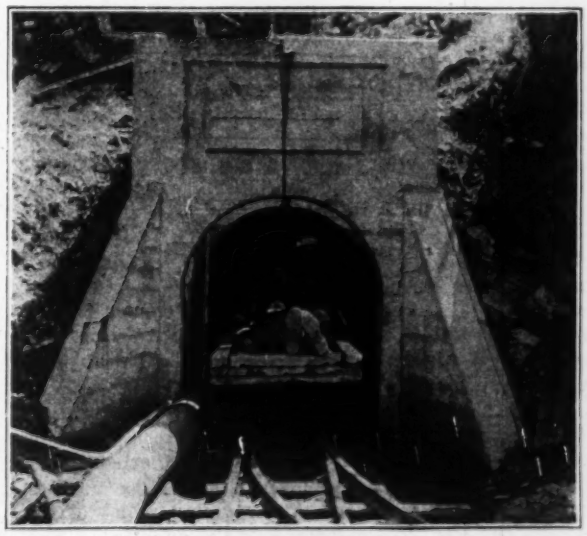
Rails were laid and a 220-volt trolley line was strung through the tunnel so trains could be operated electrically, but in order to secure the maximum clearance mentioned large pieces such as motors, steam-shovel boilers, and other equipment that could not be cut apart, had to be taken through on a special "low" car which was pushed through by hand, a trip that required from 9 to 11 hours. The operation of the tunnel railway is under the direction of the City of Santa Barbara, the cost to the contractor being $2 per ton laid down beneath the aërial cableway near the dam, 2000 ft. upstream from the tunnel.

Trains are operated through the tunnel for 16 hours out of each 24, there being two 8-hour shifts on each train crew. There are four locomotives, one considered a spare, so it is expected that three trains will be in service continually. It is expected that one of these will be loading or unloading while the others are going and coming. A siding was provided midway in the tunnel, so trains ordinarily pass at this point. The time required for a round trip is about an hour. With three trains, allowing for time of loading and unloading, there should be therefore a trainload delivery at destination every 30 minutes.

Cement is taken through in three-car trains, the load being 51 sacks per car. Each car is covered with heavy tarpaulin for protection from the leakage in the tunnel and the splashing from the car trucks. The cement is not unloaded from these cars at the railway terminal, the cars being picked up bodily from the rails by the cableway carrier and hoisted across the gorge to an eminence at one end of the dam.

Between July 9, when the contract was signed, and Sept. 1, when the first concrete was poured, there went through the tunnel piece by piece two 1-cu.yd. mixers, six electric hoists, rock screens, skips, hoppers and a steam shovel which the contractor had selected with an eye to the fact that the boiler would just meet the tunnel clearance requirements. Between shipments of all this equipment there were also handled through the tunnel 40,000 sacks of cement and 275,000 ft. b.m. of lumber. By reason of this expeditious delivery the contractor was able to pour 15,000 cu.yd. of concrete in the first three months; sometimes a day's run was as high as 420 cubic yards.

Getting the larger equipment through the tunnel meant using an oxyacetylene torch to cut each machine to pieces and, after the pieces were delivered at destination, welding them together again with a similar oxyacetylene apparatus. Perhaps the largest welding job was on the big concrete mixers whose mixing chambers were cut neatly in half and successfully welded again at the site of the dam. In fact, of the two mixers that were sent through the contractor finished with one and cut it apart again, and after it had been returned to Santa



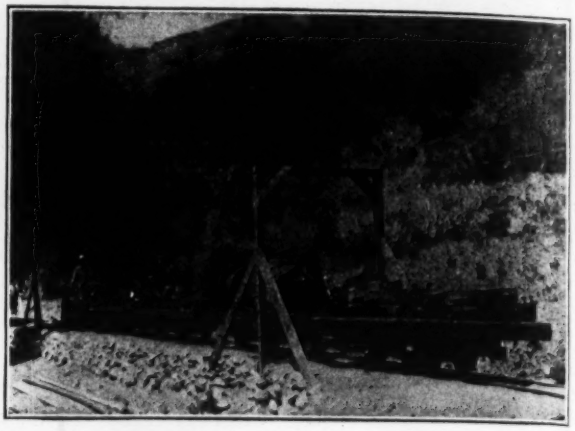
PORTAL OF 4-MILE TUNNEL THROUGH WHICH PASSED ALL MATERIAL AND EQUIPMENT

Barbara it was welded up for the second time and was then still in first-class condition.

The largest assembly job was that of putting together a steam shovel. The miscellaneous collection of machinery had all the general appearance of a wreck. The boiler had to go through intact, but practically all the other large parts were dismantled. The platform and turntable were taken apart, and even the teeth were taken off the bucket. Approximately 1000 rivets were cut out in dismounting the shovel and later put back at the dam.

Special tank cars were built for conveying fuel oil through the tunnel, as the city refused to run the risk of possible leakage into the water-supply system from oil transported in barrels. Dynamite the city absolutely refused to permit in the tunnel, so this had to go by pack horse over a long, rough trail. The work was closed down for the winter in December, but it is expected that it will be completed early this year.

Quinton, Code & Hill are consulting engineers on the work. The contract is being carried out by Bent Bros. and W. A. Kraner, the latter being in personal charge of the work. E. E. Haskell is resident engineer for the city.



CONSTRUCTION MACHINERY ON WAY TO DAM

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Deterioration of Burlap in Waterproofing

Sir—The communication in your issue of Feb. 27, 1919, p. 440, by J. B. W. Gardiner, on "Deterioration of Burlap in Waterproofing," comes to me as a considerable surprise. Mr. Gardiner states "reference to any standard work on industrial organic chemistry will show . . . that it is the most perishable of all vegetable fibers; that even the small amount of moisture in the air will cause it to deteriorate very rapidly, and, finally, that this rate of deterioration is greatly increased where the moisture carries alkali."

This is great news to me. I should like to get a list of the standard works on industrial organic chemistry that make this statement; I should like to know why it is that ever since linoleum and floor oilcloth have been invented burlap has been used as the foundation for the manufacture of this important product. I should like to know why burlap when used in floor coverings does not rot or deteriorate even if water soaks in between the seams, and I should also like to know why the sandbags used in Europe during the great war for the protection of buildings, particularly, and for the protection of the parapets of trenches, stood up so thoroughly and completely even though they were soaked with rain and mud, and the burlap bags served a remarkably useful purpose.

Furthermore, I should like to know by what process of reason or chemistry cellulose fibers are attacked by weak alkali. I know from my own experience that the animal fibers like wool are attacked by alkalies, and vegetable fibers like cotton or flax resist alkali; in fact, the well known method of the analysis of wool which is mixed with cotton or cellulose fiber is to apply the caustic alkali test. It is also very well known that the method of separating wool from cotton is with a weak solution which attacks the cotton and leaves the wool intact.

The oxides of sulphur generated in many of the waterproofing materials in conjunction with moisture are known to rot burlap or cotton, and if a waterproofing material is made which resists the action of water so sulphur acids are not generated, burlap will stand up as well as anything else.

I have no desire to take issue with anyone on this, but it is obvious that there are certain waterproofing materials which are unsuitable with burlap because inherently the waterproofing materials are not adaptable.

MAXIMILIAN TOCH.

New York City.

[The foregoing letter was referred to Mr. Gardiner for his comment, which follows.—EDITOR.]

Sir—Referring to the communication of Dr. Maximilian Toch, I feel flattered that I have given Dr. Toch such great news. In "Industrial Organic Chemistry," by Samuel P. Sadtler, published in 1912, we find, on pp. 307 and 308, the following statement:

"Chemically, jute differs from the bast fibers hitherto mentioned (i.e., flax and hemp) in that it contains no free cellulose but consists of a chemical compound of cellulose with lignin."

This fact Dr. Toch has overlooked and has assumed that the jute fiber contains free cellulose. It is, of course, a fact that weak alkali solutions do not attack cellulose, which is one of the main reasons why a cotton fabric, which is almost pure cellulose, is superior as a waterproofing membrane to a jute fabric. But to continue the quotation from Professor Sadtler:

"It is much more easily affected by the action of acids and alkalies than flax or hemp. The influence of air and moisture will also rot the jute fiber. It cannot be bleached safely with chloride of lime because of the readiness with which the fiber is oxidized."

Again, in the "Manual of Chemical Technology," by Rudolph von Wagner, published in 1904, we find on p. 811 the following, referring to jute:

"It is not a material adapted for purposes of nautical application as it has not sufficient firmness to withstand water."

And in J. Merritt Matthews' "Textile Fibers," on pp. 405 and 406, we find that "the chief defect of jute is its lack of durability; when exposed to dampness it rapidly deteriorates." Also, "Jute is also more sensitive to the action of chemicals in general than cotton or linen. . . . Treatment with alkalies . . . weakens and disintegrates the fiber to a considerable extent."

I might go on indefinitely with similar quotations, but when it is appreciated that we are not dealing with free cellulose at all but with a new compound with essentially different characteristics, it would seem unnecessary. The susceptibility of burlap, which is a jute fabric, to air, water and alkalies having been settled, the only question remaining is this:

Is it logical to place in the very heart of a waterproofing system and as an essential part of it a material which, it is known, will be destroyed by contact with those elements against which it is designed to give protection? J. B. W. GARDINER.

New York City.

More Light on Engineering Compensation

Sir:—Since you published my letter on engineering education and compensation on March 6 (p. 482) I have received a number of letters asking my opinion of the proper compensation to be paid to draftsmen on various classes of designs, and to surveyors, instrumentmen, chiefs of parties, and the like. This fair rate of compensation manifestly lies somewhere between what the meanest employer is willing to pay and the largest amount a man engaged in the work—and skilled in it—honestly thinks it is worth. It varies in different sections of the country and in different years. Several attempts have recently been made to fix such compensation, by engineering organizations. The recommendations I have seen are fair averages of what I am told are the rates for the most competent men in their respective classes. It is doubtful, however, that recommendations made by the employing class alone will ever be accepted as satisfactory by employees.

My letter of Mar. 6 did not discuss the actual amount of compensation paid today to employees of engineering offices. It dwelt entirely on the relation between the years of study and the expense of the education, and the very moderate salaries which large numbers of young men find to have come to them after such study and expense. There is little if anything about the study of higher mathematics, chemistry, physics, the strength of materials or the stresses in long-span bridges which fits the student of them to be better citizens, and consequently the value of the education must lie in the increased earning power of the person who completes the four-year undergraduate technical course of instruction in these and related subjects.

The information I have collected concerning the compensation of graduates of five or more years' experience in earning their living with the help of their technical studies has raised a doubt in my mind regarding the value of much of the undergraduate instruction, for many of the students. Is a four-year course of study which does not insure more than $1800 after five years and not more than $2500 after ten years necessary or even desirable, except for those whose circumstances are such that the education imposes no hardship on the family of the student? Would it not be far better to give a short, thorough course in those subjects every civil engineer must know and then, after actual experience has shown the young man in what direction he desires to acquire special knowledge, let him come back for special instruction in subjects of restricted interest necessary only to specialists?

Upper Montclair, N. J. JOHN M. GOODELL.

How Were Cost-Plus Contracts Obtained?

Sir—In your issue of Mar. 6, 1919, p. 485, is a communication from J. B. Chaffey, major, Quartermaster Corps, U. S. A., Fort Sill, Oklahoma. He descants upon the beauties of cost-plus contracts. What especially interests me he does not touch upon—that is, how to get one. I am a contractor and tried hard during the war to get a cost-plus contract, not only in construction, but also in spruce production. What I received was a polite bowing out. I could not find any way at all to break in.

I might mention that I am not at all a politician, not a Democrat, and have no pull of any kind. I have tried hard to find how to get these good things, and for the life of me can't find anyone who will point the way; so if the major will tell how these contracts can be had I would greatly appreciate it.

I was never fortunate enough to get a chance to look into the vitals of one of the cost-plus contracts, so could not criticise them, and have an idea that if I were a supervising engineer and had a friend that I wanted to see make money and be absolutely safe I would work him in, but in an ordinary contract the less "force-account" work an honest contractor has the better off he is, so I am sure the Government cost-plus is a great improvement on the usual "force-account" of civilian engineers.

There has been advanced a form of cost-plus contract in which there is competitive bidding and which extends a margin of safety, though not a limitless margin, that I wish engineers would pay more attention to—a much better plan than that adopted by the Massachusetts Highway Commission, I think. It is the sliding scale of profit and division between contractor and contractee. E. T. JOHNSON.

Portland, Ore.

[The plan of the Massachusetts Highway Commission referred to in the foregoing letter was published in *Engineering News-Record* of July 26, 1917, p. 172.—EDITOR.]

Chicago Engineers Endorse Labor Bureau Employment Service

Sir—In your issue of Feb. 13, p. 328, appeared an article by C. E. Drayer, secretary of the American Association of Engineers, attacking the activities, or lack of them, of the General Committee of Technical Societies of Chicago, more especially along the lines of employment service.

Mr. Drayer puts the case very positively; namely, that there were but two courses open to the General Committee—to get behind the employment service of either the American Association of Engineers or of the Professional and Special Section of the United States Employment Service, Department of Labor. The committee is quite in accord with Mr. Drayer to this extent. It finds that the United States Employment Service is being run with great intelligence and skill under the direction of trained engineers and technical men, giving valuable service absolutely free of charge

to all technically trained people who are out of employment, either returning soldiers or those who may be out of work for any other reason. On the other hand, they find that applicants to the employment service of the American Association, before they are registered for a position, must pay $6 and sign an application for membership in the association, and before they receive a chance for a position must pay $10 additional, or $16 total, upon election to the association. This payment is waived for a period for men in uniform.

With the above situation in mind, the committee which represents a number of technical societies and is interested in the welfare of technical men regardless of their society affiliations, decided that the free service of the United States Labor Bureau was what they should endorse and work with rather than the paid service that carried with it the propaganda of one society alone.

FREDERICK K. COPELAND,
Chairman, General Committee of
Chicago, Ill. Technical Societies of Chicago.

Canal Seepage, Temperature and Evaporation

Sir—In the article on "Canal Seepage Losses Are Affected by Temperature," by Lynn Crandall, in *Engineering News-Record* of Feb. 13, 1919, p, 323, no mention is made of the loss of water by evaporation. The loss over the entire canal system of 2600 acres of water surface is computed from daily records of use and supply, and is called seepage. The loss thus computed is the sum of two losses: (1) That which seeps into the ground through the wetted perimeter and (2) that which is evaporated from the water surface. It is well known that the rate of evaporation from a water surface increases rapidly with increase in temperature —it may be 100% greater during July than during April. Therefore, to study the effect of temperature on the loss due to seepage, the loss due to evaporation should first be measured and eliminated. E. C. MURPHY.

Napa, Calif.

[To the foregoing letter the following reply has been received.—EDITOR.]

Sir—In reply to Mr. Murphy's inquiry regarding evaporation losses, I would say that these losses are such a small percentage of the seepage losses in irrigation canals under normal conditions that it is generally customary to consider them as part of the total loss, which for convenience is usually called "seepage."

The evaporation losses become more important in the studies of water requirements of plants where relatively large areas of moistened soil in the fields are subject to evaporation, and in reservoir storage projects, but they are of minor importance only in the study of canal losses in earth formation.

A United States Weather Bureau Class A evaporation station has been maintained at Jerome in connection with the hydrometric studies. The following are the observed amounts of evaporation in inches during the 1917 irrigation season: April, 4.23; May, 6.40; June, 9.17; July, 8.20; August, 7.03; September, 3.60; total, 38.63.

The relation between evaporation from floating pans in canals of average size and evaporation from pans on the ground, given above, varied from 65% to 72%, averaging 68%, during the irrigation season. The evaporation from the floating pans, corresponding to the 38.63 in. from the ground pan, was 26.2 in. for the season.

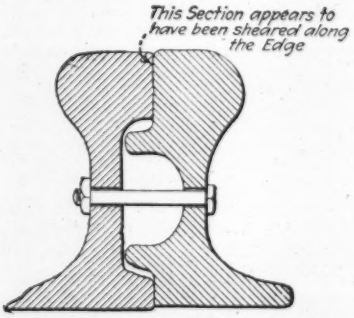
The total loss during the 1917 season due to seepage and evaporation averaged 0.70 ft. depth per day over the water surface area in the canal system, or a total for the six months' season of 128 ft. in depth. The loss due to evaporation is accordingly only 1.7% of the total loss—or, in other words, the seepage loss in three days is equivalent to the evaporation loss during the entire six months' season.

The larger loss with increasing temperature is due to the fact, not always fully appreciated, that water moves through soil more readily when warm than when cold. This has been brought out by Allen Hazen in the development of his formula on ground-water flow, and by Prof. C. S. Schlichter in Water Supply Paper No. 140 on the "Rate of Movement of Underground Waters" (United States Geological Survey).

Jerome, Idaho. LYNN CRANDALL.

More Peculiar Railroad Rail Sections

Sir—The diagram reproduced here was taken from a paper-weight which has been in the real estate office of the Baltimore & Ohio R.R., for years, and may be of interest in connection with the peculiar sections



shown in your issue of Feb. 27, 1919, p. 441. The bolt was probably put in simply to hold the parts in place.

No one here seems to know where these rail sections originally came from. W. H. MCLAUCHLAN.

Baltimore, Md.

Wider Pavements Needed by Motor Vehicles at Curves

Sir—The article by G. S. Eaton on "Wider Pavements Needed by Motor Vehicles at Curves," in *Engineering News-Record* of Mar. 6, 1919, p. 461, is both interesting and exceedingly timely. It marks, I believe, a step in the direction of substituting scientific analyses of such problems for "rule-of-thumb" methods—a thing long needed in highway work.

It will be noted that the analysis as given is for the trace lines of the wheels and is of course satisfactory for single-track roads. For double-track roads, however, it should be noted that the fender clearance lines and not the wheel trace should be used. For the vehicle on the inside of the curve, this can be determined by the formula with sufficient accuracy if $R_1 + B$ is made to equal the distance from the center to the outer face of the fender, and L the distance from the center of the rear wheel to the front end of the fender. Sufficient

clearance must then be allowed to the inside wheel trace of the vehicle on the outside of the curve, and then the formula giving the radius of the outer wheel trace can be used. Some measurements of my own on a truck with a wheel-base of 13½ ft. show that, on a curve with an inside radius of 40 ft., nearly 9 in. more width is required to the fender line than to the wheel trace.

Incidentally, it might be noted that, where the quantities are odd, the trigonometric method of solving a right triangle is invariably faster and less subject to error than the "square root of the sum of the squares" method. In a case of this kind the "correction method" is even more suitable, and the formula is much simpler to use and sufficiently accurate in the form:

$$R_2 = R_1 + B + \frac{L^2}{2(R_1 + B)}$$

C. C. WILEY.
Associate, Civil Engineering Department,
Urbana, Ill. University of Illinois.

Gas Plant Wastes and City Water

Sir—The article by H. P. Bohmann, on "Obnoxious Tastes in Milwaukee Water" in *Engineering News-Record*, of Jan. 23, 1919, p. 181, reminds the writer of a similar experience encountered several years ago. The Quincy water-works office had always received occasional complaints regarding the water. Many of these complaints were due to sudden changes in the character of the water at the source of supply, the Mississippi River. Others were probably due to algæ growths in the storage reservoir. But in 1911 complaints of a medicinal taste in the water began to come in. Some of the persons entering complaints described the taste as being similar to that of carbolic acid; others thought it was creosote and still others mentioned iodoform and ammonia.

These complaints were not of daily occurrence. They were received at intervals of a month or six weeks. When they came, several were usually received within a few minutes, but by the time an inspector could get to the source of the complaints the trouble was practically over. It soon became evident, however, that these complaints began in the vicinity of the gas plant and followed the direction of flow of the water in the mains from the gas plant to the city limits. No complaints were received from the consumers living along the 10 blocks of mains lying between the pumping station and the gas plant.

An examination of the check valve on the 2-in. water service running into the gas works revealed the fact that something more corrosive than city water was getting through it. It was no longer a check valve, and it was very evident that gas-house liquids might be forced or drawn into the water mains at any time by the simple process of shutting off the water pressure in the district at the gas plant. Two check valves were inserted tandem in the service pipe, in 1912, and there has been no recurrence of the trouble.

At the time this trouble developed the Quincy water-supply was not sterilized. When the source of the taste was finally located, hypochlorite was being used. This would indicate that the addition of chlorine is not necessary to develop the obnoxious taste from gas-house waste.

W. R. GELSTON,
Quincy, Ill. Superintendent Water Department.

History and Use of the Manning Formula

Sir—On reading the letter by H. R. Leach and R. E. Horton on the Manning formula, in *Engineering News-Record* of Mar. 13, 1919, p. 536, it occurs to me that American engineers generally are not very familiar with that formula. Accordingly, I submit the following notes on the history and purpose of the Manning formula:

Before the publication of Parker's "Control of Water," the so-called Manning formula for open channels was not generally known to American engineers. It has, however, been used by English engineers, to some extent, in India, Australia and Egypt, during the past 20 years. It is mentioned in "Elementary Hydraulics," by Sir William Willcocks, 1899, and in Flamant's "Hydraulique," of about the same date. Buckley's "Irrigation Pocket Book" (second edition, 1913), contains an interesting discussion of the relation between Kutter's and Manning's ≃

It is interesting to note that the Manning formula apparently never was written by Manning in the form now used. Manning's investigation (Trans. Inst. C. E. of Ireland, Vol. XX, 1891) resulted in the derivation of an open-channel formula which has now little more than historical interest. The formula which is now used and bears Manning's name appears to be simply the result of a casual observation.

As a step in the derivation of the formula which he recommended, Manning investigated the formula $v = cr^{\frac{1}{2}} s^{\frac{1}{2}}$ and noted that the value of c (with the formula expressed in metric units) appeared to be very nearly equal to the reciprocal of Kutter's n. He did not, however, write the formula in the obvious form $v = \frac{1}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$, in which n is to be given the same value as n in Kutter's formula. This is what is now generally known as the Manning formula expressed in metric units. Expressed in English units the formula becomes,

$$v = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$$

The advantages claimed for the Manning formula are chiefly those of simplicity. Results obtained by using this formula agree very closely with those obtained with the Kutter formula, and those engineers who think of open channels in terms of Kutter's n may shift to a simpler formula without familiarizing themselves with a new set of coefficients and, it is asserted, without making any sacrifice in accuracy.

HORACE W. KING,
Professor of Hydraulic Engineering.
University of Michigan, Ann Arbor.

Water Treatment in Detroit Effective

Two pounds of liquid chlorine per 1,000,000 gal., costing Detroit 33⅓c. per 1,000,000 gal., reduced the gelatin 20-deg. bacterial count on the average from 213.7 to 10.6 per cubic centimeter. B. coli in 1 c.c. in the river water was found on six days, or 17 times in 772 tests. In 10-c.c. portions positive reactions were obtained on 178 days, or 642 times in 3860 tests. None was found in the treated water in 1-c.c. samples out of 775 tests, but in 10-c.c. samples the tests were positive on 22 days, or 23 times out of 3875 tests.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Cafeteria Plan Cuts Time of Serving Meals in Camp Mess

MESS-HALL arrangement and cafeteria service made possible the serving of meals in 25 min. to 1360 men constructing the extension to Camp Custer, Michigan. From Oct. 6 to Dec. 31, 1918, a total of 161,609 meals was served at a cost to the workmen of 33⅓c. per meal. The actual cost of each meal was 30.8c.; the remainder was profit. To accommodate the construction force, four regulation Army mess halls were connected, as shown by the drawing, using temporary construction consisting of two serving rooms and a kitchen. The meats and vegetables, when prepared, were put in copper steamers and removed from the kitchen to the steam tables, in the serving room, where they were kept hot for serving. There was one central entrance to each serving room, and the steam tables were located on either side of the two entrances. The workers passed in two lines through the turnstiles and into each serving room. At the tray and plate tables, directly opposite the entrance, the lines separated, turning to the north and south wings, and as the men passed along the steam tables they were served with meat, potatoes and two other vegetables. At the adjoining tables they received dessert, coffee, knives, forks and spoons. Then, continuing in formations, they filed into the mess halls and seated themselves at the tables. The bread and butter were served on the tables and, with this exception, it required only 25 min. for serving the food for 1360 persons, the total capacity of the four mess halls. The number of waiters depended entirely upon the number of meals served. When the noonday meals averaged 1300 daily there were two waiters stationed in each mess hall and seven at each set of serving tables, making a total of 36. During the week of Nov. 8 to 14, inclusive, when 17,859 meals were served, the mess hall force consisted of one manager, two assistant managers, two bakers, one bakers' helper, six cooks, three vegetable men, 38 waiters, seven dishwashers, four scrubmen, three laborers, one ticket seller, four checkers, three exit men and one storekeeper.

The construction of the extension to Camp Custer was under the direction of Maj. T. A. Leisen, constructing quartermaster, and Samuel A. Greeley, supervising engineer. The W. E. Wood Co., Detroit, Mich., was the general contractor. M. D. Kauffman was division engineer in charge of sanitation. In last week's issue of *Engineering News-Record*, p. 619, Mr. Kauffman told how the sanitary service rid the extension to Camp Custer of influenza.

Other Articles in This Issue of Interest to Contractors:

Solving Construction Problems in Canal Street Subway — Page 650

Associated General Contractors Adopt Constructive Program — Page 669

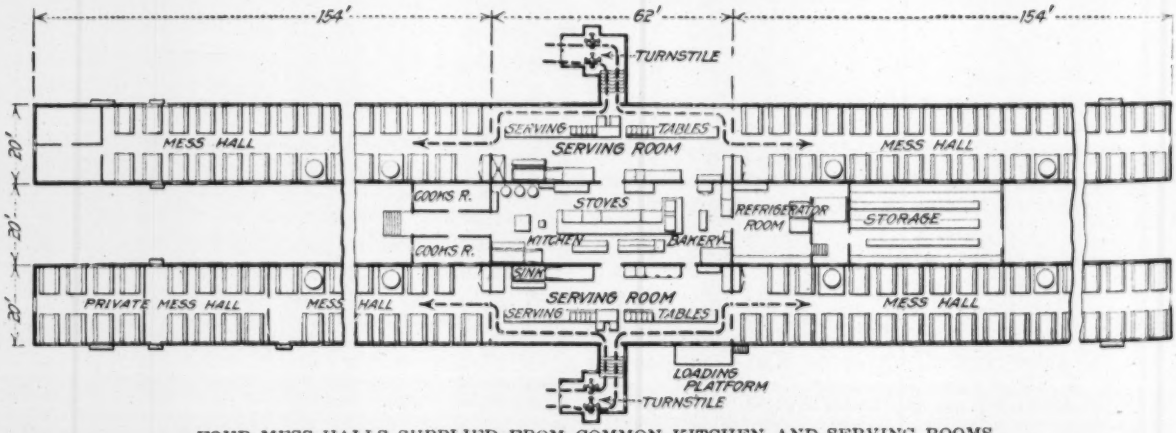
Spraying Paint on Corrugated Steel Before Shipment — Page 676

Move Equipment and Material for Dam Through Small Tunnel — Page 681

How Were Cost-Plus Contracts Obtained? (Letter) — Page 683

Saucer-Topped Garbage Table Prevents Spattering

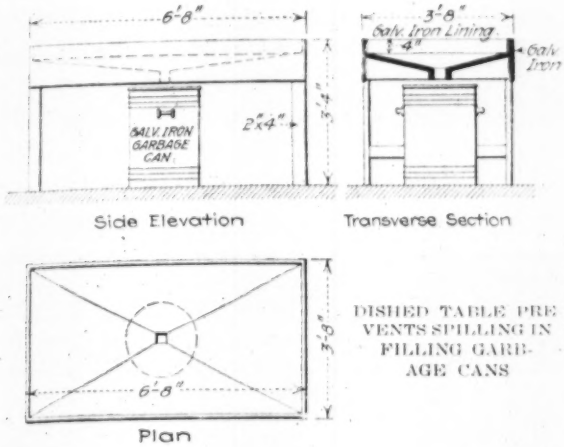
CLEANLY handling of garbage in a construction camp mess hall for the workmen building the extension to Camp Custer, Michigan, was made easy by dished tables and covered cans. The dished top of the garbage table was sheeted smoothly with galvanized iron. Through an opening in the center the garbage fell into the garbage can, which was of a height to fit closely under the table and thus prevent spattering.



FOUR MESS HALLS SUPPLIED FROM COMMON KITCHEN AND SERVING ROOMS

The dash lines indicate the lines of travel of workmen through the turnstiles, past the serving tables, to places in the mess halls

Each can held 40 gal. When filled it was covered and moved to the loading platform outside the kitchen. From here the cans were loaded into wagons designed to hold 15 cans, and were hauled to the garbage burying ground. The dished, iron-covered top of the table



DISHED TABLE PREVENTS SPILLING IN FILLING GARBAGE CANS

made washing and scouring easy, and was large and deep enough to eliminate spattering unless the kitchen help was grossly careless in the handling of the camp garbage. The names of the officials in charge of the camp are given in the preceding page, in the article describing the cafeteria plan of serving meals there.

Derrick With Drop Weight Wrecks Old Concrete Building

WRECKING a reinforced-concrete structure by means of a drop hammer, acetylene torches and cables was work required in the removal of part of the old National Guard armory in Minneapolis, Minn., in 1918. This proved a difficult task, owing to the great thickness and density of the concrete. Some of the floor slabs were nearly 2 ft. thick, and it is stated that concrete seemed to have been poured in to level up the floors in some parts. In the main hall the floor was 14 in. thick.

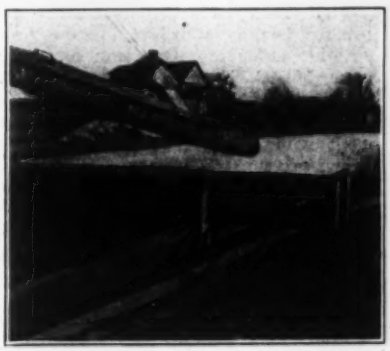
For breaking up the floors, a stiffleg derrick with a 20-hp. engine was installed, handling a 2600-lb. drop weight. At first an ordinary pile hammer was used as the weight, but this proved unsatisfactory, as it cut the wire strands of the cable. A pear-shaped drop was substituted, therefore, and was similar to the drop used in the wrecking of a Chicago building, as described in *Engineering News-Record* of Dec. 27, 1917, p. 1208. The Minneapolis derrick had a 40-ft. mast and a 60-ft. boom, using a drop of about 20 ft. as a rule, although at times this was increased to 40 ft. This machine was stationed first on the top story, so that it could break down the roof and then the floor, being shifted over the floor as required. It was then moved down to the lower floors, successively. Blows were concentrated at the center of the panel whenever convenient, but this plan could not be followed generally, as the work had to be done in such a manner that the vibration would not affect the remainder of the building, which has a large auditorium with the front part of the roof carried by a 160-ft. steel truss. The lower portion of this truss was connected to the slab which had to be broken down in the adjacent part of the building, so that special care was necessary to prevent damage to the truss.

Concrete girders were either broken by the drop hammer or pulled down by slings and the cable of the hoisting engine. Most of them were pulled down and then broken up on the floor by the drop weight, these blows also helping to break the floor slab. Concrete columns were pulled down and broken in the same way. An acetylene torch was used in cutting the reinforcing bars. The débris was wheeled to a chute ending in a large bin from which the wagons were loaded, the loading being done in this way in about two minutes.

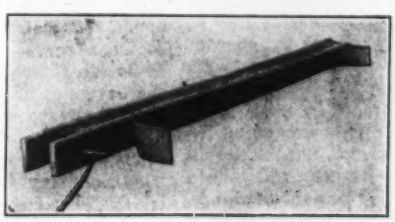
Dynamite was necessary to blow up the brick arch over the main entrance, as this work was done after the derrick had been removed and hand labor was too slow. The wrecking of this part of the building and the erection of a lighter structure to replace it was done by the Cleveland Wrecking & Contracting Co., Minneapolis, Minn.

Curved Steel End Plates for Concrete Screed Prevent Waste

TO PREVENT the concrete which piles up in front of a screed on a concrete paving job from wasting over the sides as the screed is pulled back and forth, the Merrill Road Improvement Co., of Chattanooga, Tenn., has devised a curved steel plate, which is fastened to the screed, and projects out in front of it. With one of these plates at each end of the screed, the surplus concrete at the edges is dragged toward the center of the pavement each time the screed moves from side to side. Another feature is the method of operating the screed. At each end is a steel rod by which the screed is pulled back and forth, and a rope by which it is pulled forward. This arrangement is a good one for getting good screeding, as the men who pull back and forth do not pull forward, and the men who pull forward cannot push backward. This gives a steadily forward motion, and eliminates the possible backward movement which causes poor screeding. The pictures were taken on Government road work between Fort Oglethorpe, Georgia, and Chattanooga, Tenn. Maj. P. M. Ripley is constructing quartermaster, under whom W. L. Dodds is engineer in charge.



SCREED OPERATED BY ROD AND ROPE



BENT PLANK ATTACHED TO SCREED

NEWS OF THE WEEK

April 3, 1919

Hurley Submits a Plan for Steel Ship Operation

Would Sell Vessels at Market Price but Retain Control for a Limited Period Through Mortgage

Chairman E. N. Hurley of the United States Shipping Board announced in a speech in New York last week a proposed plan for the future control and operation of the ships which have been built under the auspices of the United States Shipping Board. Briefly, the scheme which he purposes to recommend to Congress contemplates the eventual sale of all of the Government-owned ships to private interests, but the retention of partial Government control through a period of years by means of the Government holding of a mortgage and the Government issuance of insurance. There is to be established a special fund, under the control of the Government, which will be used to foster the development of certain trade routes.

Mr. Hurley stated that when the present contracts are completed there will be under the American flag next year 16,732,700 dead-weight tons of oceangoing steel cargo and passenger ships. He is convinced that Government ownership and operation of these ships, except as a last resort, is undesirable. On the other hand, he thinks that were the ships built at Government expense to be used now merely for the advantage of groups of ship operators with sufficient capital to purchase the ships from the Government, he would unhesitatingly advocate the retention of the whole fleet by the Government. His plan is intended to provide as soon as possible the necessary development of the American merchant marine, at the same time guaranteeing to the people of the United States as large a return as possible from the war expenditure for ships.

Prices for Sale of Ships

The primary recommendation of the plan is that the ships should be sold at a price which fairly reflects the current war market for similar tonnage. Twenty-five per cent. of the purchase price of each ship is to be paid down, the remainder to be paid in annual installments over a period not exceeding 10 years. The Government will take a mortgage for this unpaid balance, charging interest at the customary commercial rate of 5%, but inasmuch as the Government ordinarily borrows money at 4%, the 1% difference will be diverted to the merchant marine development fund noted above. At the same time, the purchaser is to be re-

(*Concluded on page* 690)

Employment

For the convenience of engineers returning from military life, and others, there are listed below agencies which may be helpful to those who are seeking employment:

Engineering Societies Employment Bureau; secretary, 29 West 39th St., New York City.

American Association of Engineers, 29 So. La Salle St., Chicago. Service to members only, but Army or Navy engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, maintained by the Joint Council of Engineering Societies of San Francisco, Engineers' Club, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Hold Hearing on Professional Railway Engineers' Wages

Representatives of Engineering Council and of the American Association of Engineers appeared before the Railroad Administration at Washington on Mar. 31 and Apr. 1 in reference to the proposed revised scale for the professional engineers in railway service. By restriction of a previous ruling of the administration consideration at this hearing was confined to salaries below $250 per month.

Seattle Acquires Street Railways

Transfer of the Seattle street-railway lines of the Puget Sound Light & Power Co. to the city for $15,000,000 in bonds was made Mar. 31, to become effective Apr. 1. The interest and redemption charges are to be paid from the revenues of the system. The company agrees to sell current to the city at 1c. per kilowatt until the city is ready to supply its own current. Some 2000 company employees will be put on the city payroll. Negotiations for the purchase of the Seattle & Rainier Valley Ry. are said to be well under way. The city already has some municipal street-railway lines. Thomas F. Murphine, superintendent of public utilities, announces that tickets will be eliminated and the nickel made the standard fare, except for children.

New York Engineers Move to Form Local Society

Action Taken at Meeting Called to Discuss the Engineer as a Citizen

On Mar. 26 a meeting in New York, having as its theme "The Engineer as a Citizen," resulted in the adoption of resolutions looking to the organization of a New York local engineering society, through the affiliation of existing locals and of local sections of the national engineering societies.

The meeting was held under the auspices of the New York local sections of the mining, mechanical, and automotive engineers' societies. The local members of all other societies were invited to attend and participate in the discussion. Gano Dunn presided. Philip N. Moore, of St. Louis, spoke on the civic responsibility of the engineer, Calvert Townley on his relation to legislation, Nelson P. Lewis on his relation to administration, Spencer Miller on his relation to public opinion, and Comfort A. Adams on his relation to production and distribution. In the main, the addresses followed lines already well covered in discussions of these topics. There was repeated emphasis on the need for the engineer's clear thinking in the present social crisis, while the governing idea in Mr. Miller's discussion was that the engineer's influence on public opinion would be in proportion to his spiritual strength and his character.

Except for discussions by J. E. Johnson, Jr., and G. S. Van Gilder, the remarks following the opening discussion referred to professional organization, and particularly to that of the engineers of the metropolitan district. Mr. Johnson, pointing out the function of the Engineering Council, declared that its membership was too much concentrated in New York and that it lacked the authority necessary for a strong unifying body. One of the reasons for the failure of engineering societies to rise to their responsibility, was, in his opinion, that those elected to office are men who have made reputations and do not want to risk spoiling them by turning their hands to new tasks. Lieut. Van Gilder pointed out that the responsibility of the engineer for the sociological conditions springs out of the present industrialism, which is the creation of the engineer.

Daniel L. Turner, chief engineer of the New York Public Service Commission, in the discussion of professional organization, urged the support of the American Association of Engineers as the unifying medium in civic activity.

The resolution looking to organiza-

tion of a New York local engineering society suggests that action be taken through a meeting of the secretaries of local sections and local societies, these secretaries then to call a general meeting for consideration of whatever plan may be formulated.

Resolutions were also passed calling upon all engineering societies to appoint committees on development, and upon the national engineering societies to appoint representatives to a conference committee which would draw up a simple, standard code of ethics.

The meeting was fairly well attended. Perhaps the attendance would have been larger had the notices supplied to the American Society of Civil Engineers for mailing actually been sent out to the New York members of the society.

Northwest Association of General Contractors Formed

The Northwestern Association of General Contractors was organized at a meeting held in St. Paul Mar. 26-27, at which D. A. Garber, president of the Associated General Contractors of America, and G. W. Buchholz, acting secretary, spoke on the work of the national association in its relation to local organizations. The convention was attended by about 100 of the most prominent contractors in the Northwest territory, including Omaha, Portland, Tacoma, Seattle, Duluth, Kansas City, and Grand Forks, N. D.

J. H. Ellison, of Minneapolis, spoke on "Relations of Employees and Employers," and W. L. Darling, of St. Paul, on "Unit Price Contracts." The following officers were elected: President, W. O. Winston, of Winston Bros. Co., Minneapolis; vice-president, Charles Ffolliott; second vice-presidents, A. Guthrie, of St. Paul, and Charles B. Hurley, of the Hurley-Mason Co., Tacoma; secretary, H. M. Leighton, of Minneapolis; treasurer, Claude H. Siems, of Siems, Helmers & Schaffner, of St. Paul.

Concrete Pipe Association Reorganizes

The American Concrete Pipe Association was reorganized by action of the annual convention, Feb. 14-15, and by further action of the executive committee, which met at Chicago Mar. 15. Greater support has been voted for the technical committee studying concrete sewer pipe, drain tile, and culvert pipe, and a series of tests has been outlined for further study of the reinforcement for culvert pipe.

There are at present, approximately, 400 manufacturers of concrete drain tile and sewer pipe in the United States and Canada, a large majority of which will be members of the association. It is planned to open offices in a short time, with executive officers in charge, to further the educational work which is now started.

T. H. MacDonald, Appointed Engineer of Federal-Aid Road Act

Thomas H. MacDonald, whose appointment as engineer in charge of work under the Federal-aid road act has been announced by the Secretary of Agriculture, was born in Colorado 37 years ago. He was educated as a civil engineer at the Iowa State College and, after a short service with the Chicago Great Western R.R., on track work, he became, in 1904, assistant professor of civil engineering in charge of road investigations at Iowa State College. Practically his entire professional career has been spent in developing the highway system of Iowa. The first legislation toward state supervision of road work in Iowa in 1906 placed this work under the supervision of the Iowa State College, and Mr. MacDonald became the executive officer at the beginning. As the work increased, an engineering as well as an administrative staff was placed under his direction, and, when the Iowa Highway Commission was created as an independent body he was naturally made the State Highway Engineer and its executive officer.

T. H. MACDONALD

The work in Iowa has been unusual, in that it is all done through the county organizations. It has required both engineering and administrative ability of a high order, and the successful manner in which the counties have been encouraged to develop sound engineering departments doubtless had a marked influence in the choosing of Mr. MacDonald to take charge of the Federal-aid work of the Bureau of Public Roads. While for the present he will devote his time more particularly to the solving of problems arising from the increased appropriations for Federal aid, it is planned that in the near future he will formally assume the position of director of the Bureau of Public Roads, made vacant by the death of Logan Waller Page. Mr. MacDonald has been active in a number of highway organizations and has been one of the influential members of the American Association of State Highway Officials.

Federal-Aid Road Bill Introduced In Canadian Parliament

A bill which would appropriate $20,000,000 to be used in aiding the provinces to build roads has been introduced in the House of Commons of the Canadian Parliament, at Ottawa. The bill provides for the payment of $80,000 per year to each province, plus a further payment based upon population as determined by the latest Federal census. It also provides that any highway for which aid is granted shall be constructed or improved in accordance with an agreement to be made with the provincial Government, covering cost and specifications. The amounts given to the provinces must not exceed 40% of the actual and necessary cost of the improvements. The sum of $25,000 was appropriated for the organization staff of the Highway Department, of which A. W. Campbell is commissioner.

Canadian Building Construction Industries Organized

A permanent organization of the Association of Canadian Building and Construction Industries, with headquarters in Ottawa, has been effected. A. S. Clarson, of Montreal, has been appointed general secretarial manager and organizer, and he will shortly visit the prinicipal Canadian cities for the purpose of establishing local branches. Mr. Clarson has had over 30 years' engineering experience, and during the past 10 years has resided in Montreal, practicing as a consulting engineer. The association, which was formed for the purpose of stabilizing Canadian construction industries, will coöperate with the national reconstruction movement inaugurated by the Government.

Interstate Flood Control Proposed

Interstate flood control through the coöperation of North and South Dakota and Minnesota is authorized so far as one of the states is concerned by a bill that has passed the North Dakota legislature and has been signed by the Governor. The bill provides for a flood-control commission, composed of the State Engineer, the dean of the School of Engineering and Mechanic Arts of the North Dakota Agricultural College, and the dean of the School of Mines of North Dakota. The commission will appoint a flood-control engineer. It is directed to coöperate with the Departments of the Interior and of War as well as with the States of South Dakota and Minnesota. Preliminary surveys of the Red River Valley, looking to flood control, are already being made by P. G. Simons, of the United States Department of Agriculture.

Hurley Submits Plan for Ship Operation

(*Concluded from page* 688)

quired to insure with an American marine insurance company his equity in the vessel, but the Government will carry in its own fund for the purchaser's account the hull and machinery insurance covering that part of the vessel for which payment has not been made. Inasmuch as the Government can carry this insurance for at least 1% less than the market rate, this 1%, too, will be diverted to the development fund.

Each purchaser who wishes to operate in foreign trade should be obliged to incorporate under a Federal charter, for which legislation will have to be obtained, and provision is to be made that all control shall remain in American hands. One member of the board of directors of each company is to be named by the Government, and these directors will be formed into a board of Government directors, who will have certain advisory powers in relation to the administration of the development fund. This fund is to be used to relieve such financial difficulties as may be encountered in the development of an adequate and well balanced American merchant marine. For instance, one suggestion is that if the Government thinks that a certain trade route should be opened, a company may buy ships for the express purpose of operating on that route. If operation does not prove profitable at once, it will be necessary to provide for the payment of defaulted interest from the merchant marine development fund in the discretion of the Government agency, and when the ships of the route earn their annual interest rate and a profit, one-half the profit earned each year should be paid into the development fund until all moneys drawn from that fund, on account of the vessel in question, shall have been replaced. The other half should go to the stockholders of the company. If the route does not prove profitable, the ships on it may be transferred by the Government to other routes and if the Government becomes convinced that the vessel has failed to make expenses solely or chiefly because of incapable management, it may foreclose the mortgage which it holds on the vessel.

A final clause in the plan is that, until sold under the terms stated, all vessels should remain the property of and should be operated by the Government of the United States. Mr. Hurley specifically stated that the wood ships are not included in this plan.

To Start Sewage-Treatment Works for Cleveland

Plans for sewage-treatment works at the westerly site, Cleveland, Ohio, will be ready Apr. 15 and bids will be received May 6. The plant will include grit chambers, two-story settling tanks, outfall conduits, buildings and appurtenances. This is the first of three proposed plants. Ed. Shattuck is commissioner of purchases and supplies, Robert Hoffmann is city engineer, and George B. Gascoigne is city sanitary engineer. The announcement of Apr. 22 as the date for opening bids made in our advertising columns of earlier date was due to a misunderstanding.

New Assistant Secretary for Civil Engineers' Society

The March *Proceedings* of the American Society of Civil Engineers announces the appointment of Capt. Stephen L. Coles as assistant secretary, succeeding Thomas J. McMinn, who for 21 years has been assistant secretary of the society. Mr. McMinn will continue to give the society the benefit of his experience in the society's work until Captain Coles becomes familiar with his new duties, after which the former will be retired on half pay.

Captain Coles has been identified chiefly with electrical engineering work, having made a special study of service and public-policy questions affecting central electric-light stations. After leaving the Massachusetts Institute of Technology he became Boston correspondent and later managing editor of the *Electrical Review*. He has written extensively on electrical subjects, both for the lay and engineering press, was at one time acting secretary-treasurer of the Society for Electrical Development, aided the Toronto Electric Light Co., Ltd., of Toronto, Can., in working out its general policies, and just before entering the Ordnance Department of the Army, during the war, was on the engineering staff of M. W. Thompson, specialist in litigated engineering matters and in reports on railroads and other large properties. In this work Captain Coles devoted his attention principally to electrical public utilities having problems of service, policy, and competition to solve.

Captain Coles is not a member of the society.

National Lumber Manufacturers to Hold Convention

The National Lumber Manufacturers' Association will hold its annual convention Apr. 16-17, at the Congress Hotel, Chicago. Most of the sessions will be devoted to a discussion of subjects which more particularly pertain to the industry, but on the morning of Apr. 15 a technical session will be held at which the following subjects of interest to engineers will be presented:

"Standards of Wood Construction from the Standpoint of the Architect," by Sullivan W. Jones, chairman of the Structural Service Committee, American Institute of Architects; "Commercial Uses of Treated Lumber," by A. R. Joyce, acting president of the American Wood Preservers' Association; "Development in Heavy Timber Construction," by C. E. Paul, construction engineer, National Lumber Manufacturers' Association; "Protection from Fire in Wooden Buildings," by W. C. Robinson, vice-president and chief engineer of the Underwriters' Laboratories.

Two-Day Technical Meeting of Water Producers

Purification and Other Topics Occupy Attention of Illinois Section of Water-Works Association

Practically all of the twenty papers presented Mar. 25-26 at the well attended meeting of the Illinois Section of the American Water-Works Association were technical. Chemical treatment for the softening, clarification and sterilization of water was treated in five papers. Well supplies, pumping, construction and operation received attention in three papers. War work was reflected in an equal number.

M. F. Stein reviewed the work of the testing station at Cleveland, Ohio, on water softening. The design of the chemical treatment process as dictated by the experimental work was brought out to indicate that local tests should precede design in most cases.

Several typhoid fever outbreaks in Moline, Ill., have occurred in the past two years. M. C. Sjoblom traced the cause to a bypass valve permitting unfiltered water to enter the clear well at a time when little or no chlorine was being applied.

Lieut. Everett Judson, of the United States Public Health Service, detailed experiments on adonite, a fermenting sugar, to differentiate B. coli. Opinions expressed in discussion indicated that the test was not yet a safe one.

Chlorine, Chloramine and Crenothrix

After a trial of more than a year the Champaign & Urbana Water Co. still finds the use of 4.6 lb. of chlorine per 1,000,000 gal. is an effective agent in eliminating crenothrix from its ground water-supply, said F. C. Amsbary. W. F. Monfort, in detailing work done on the problem in conjunction with O. A. Barnes, indicated that chloramine was a better reagent, but that the difficulties of its application and in preserving its stability made the chlorine more desirable so long as it continued to kill the crenothrix.

Minna E. Jewell has been making intensive studies of the Sangamon River, one of the most polluted streams of the state. Her findings indicate that biological tests are perhaps more practical than chemical or bacterial in determining the extent to which stream pollution may be permitted without the creation of a nuisance.

Experience with the new large-capacity 36-in. well at the University of Illinois was described by Prof. M. L. Enger. Unlike the smaller wells, its capacity per foot of draw-down has increased in two years from 19.5 to 21.5 gal. per minute. One of the older wells was reduced in 10 years from 7.2 to 4.9 gallons.

Consumption of water at Illinois state institutions varies from 70 to 350 gal. per capita per day, said F. J. Postel. Meters are installed on the low-consumption systems. Deliberate waste of water through compression

cocks in the reform school where the boys balanced the valves open so as to wash in running water is being stopped by arranging the cocks with a stop which prevents opening them wide. So serious was the water shortage in Jacksonville in the winter of 1918 that snow was thrown into the reservoirs and even brought in to the bath tubs. Wells are always provided at state institutions because of their desirability if there is any chance of an adequate supply being found.

UNUSUAL WELL-WATER SUPPLY AT BATON ROUGE

L. R. Howson outlined the unusual well-water supply conditions of Baton Rouge, La., where 2050-ft. wells deliver water at a temperature of 92° F. with a static head of 120 ft. One well sunk in 1916 discharged for 6 hours at night directly into the city mains, delivering at a 300,000-gal. rate and maintaining a pressure of 30 lb. The practice has recently been discontinued on account of additional pressure required for automatic sprinklers. There are 14 separate sand strata bearing water of different character. Through the fine sand of Louisiana water at 92° is transmitted 1½ times as rapidly as through a similar sand with a temperature of 50 degrees.

The Old Hickory Powder Works water-supply was described by O. E. Bulkeley. Ninety-six tub gravity filters with a daily capacity of 65,000,000 gal. were hand-operated. Determination of the rate by noting the drop each hour, and the satisfactory utilization of women as filter attendants, were features of the operation.

The officers chosen for the coming year are: Chairman, W. E. Lautz; vice-chairman, F. C. Amsbary; treasurer, H. E. Keeler; secretary, G. C. Habermeyer, Urbana.

Augusta, Ga., Flood-Protection Work Completed

Flood-protection levees at Augusta, Ga., started in 1909, were recently completed, according to a report by Nisbet Wingfield, city engineer, who has also been chief engineer of the river and canal commission which has had charge of the protection work. This whole system was described in *Engineering News* of Aug. 6, 1914, p. 277. It comprises an 11-mile earth levee with reinforced-concrete bulkhead gates at intervals from a point just above the city, three miles through the city, to a point eight miles below. It was started after the disastrous flood of 1908. Flood tide on Dec. 24, 1918, reached a height which under the old conditions would have overrun a large part of the city, but, due to the effectiveness of the protection, no damage was caused, except the shut down of power plants for a few days, owing to the shutting off of their connecting water-supply. The total cost of the work ran above $2,000,000.

Providence Water-Supply Project Goes Forward

Construction work on the new gravity water-supply for Providence, R. I., is going forward immediately, according to present plans. Bids for 5.2 miles of road work as a part of the Scituate reservoir road relocation will be received Apr. 9, and it is expected that further bids will be invited later in April. In the late summer, or early autumn, if conditions then are favorable, bids will be asked for the main dam and dike. This will involve about 2,500,000 cu.yd. of earth, besides gate chambers, masonry spillway and a reinforced-concrete bridge. Some preliminary work on the project has already been done. Frank E. Winsor is chief engineer of the Water-Supply Board.

Heavy Reduction in Lowest Bid Compared with Last August

Bids for furnishing and laying 34,590 ft. of 72-in. riveted steel pipe line to duplicate the portion of the Jersey City water-supply conduit from the Boonton reservoir to the Watchung tunnel were opened on Mar. 25. They were 15 in number. The range was from $1,098,076 to $1,783,977. The lowest bid for the same work on Aug. 13, 1918, was $1,578,921, showing a reduction of $480,845. The award was not made last year because the Priorities Board withheld its approval of the use of steel plate at that time. Clyde Potts, New York City, is consulting engineer for the work and Michael I. Fagen is director of the Department of Streets and Public Improvements of Jersey City.

Civil Service Examinations

For United States Civil Service examinations listed below, apply to United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

United States.—Engineer-draftsman, Apr. 22, $1500 to $1800 per year. File application before Apr. 22.

United States.—Transitman, $100 to $125 per month, and surveyor, $125 to $200 per month, Apr. 23-24. File applications in time to arrange for examination at place selected by applicant.

United States.—Expert patent investigator, $1800 to $2400 per year, and technical patent expert, $2400 to $3600 per year, May. 20.

United States. — Assistant material engineer, Bureau of Construction and Repair, from $4.48 to $6.40 and upwards per diem. No date specified. Applications should be filed without delay.

United States.—Statistician, Department of Interior, $1800 per year, May 13. Apply for Form 2118.

United States.—Junior recreational engineer, Forest Service, Denver, Colo., $1800 to $2400 per year, May 6. Apply for Form 2118.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION; 87 Milk St., Boston, Mass.; May 6-8, Ottawa, Can.

AMERICAN ASSOCIATION OF ENGINEERS, 29 S. LaSalle St., Chicago; May 13-14, Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 W. 39th St., New York; June 17-20, St. Paul-Minneapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 24-27, Atlantic City.

The Engineers' Club of Philadelphia was addressed at the weekly luncheon Apr. 1 by Col. W. B. Ladue, Corps of Engineers, U. S. district engineer at Philadelphia, on "Harbor Developments for the Port of Philadelphia." Dr. Henry Leffman will read a paper on "The Truth About Whisky" at the weekly luncheon Apr. 8.

The Montreal Branch of the Engineering Institute of Canada will be addressed Apr. 3 by V. I. Smart, who will speak on the "Operation of Railways as an Enginering Problem." At the meeting Apr. 10 J. A. DeCew will present a paper on "Waterproof Paper Productions and Their Industrial Possibilities."

The Architects' and Engineers' Club, Ann Arbor, Mich., is the name adopted for the new organization formed at a meeting of the engineers and architects of Ann Arbor Mar. 25, at which the object of organization was stated to be "the promotion of the social, economic, and technical interests of its members, and civic activity and public service." The club has 72 members. A committee was appointed to follow pending legislation in the state legislature concerning the regulation of public utilities, and it was instructed to exert the influence of the club for proper recognition of the engineering profession.

The Texas Association of Members of the American Society of Civil Engineers will hold its semi-annual meeting at San Antonio Apr. 25-26. R. J. Potts of Waco is president of the association and J. H. Brillhart of Dallas is secretary.

The Ottawa Branch of the Engineering Institute of Canada on Mar. 20 held its first meeting since the annual general meeting. Lieutenant Commander Edwards, superintendent of the Canadian Radio-Telegraph Service, provided a series of interesting experiments to illustrate the sending and receiving of electric waves, the meeting

being held in the testing room of the Canadian Naval Radio Telephony Service. Each member of the audience was provided with a telephone receiver and was enabled to listen to some of the high-power sending stations. The second meeting of the branch was held Mar. 27 to discuss the subject of proposed provincial legislation defining the status of engineers throughout Canada.

The Engineers' Club of St. Louis held a meeting Apr. 2, devoted to a discussion on the prospectus for a conference of engineering societies, to be held in Chicago Apr. 23-25, on the establishment of a Department of Public Works.

The Associated Engineering Societies of Seattle and **the Engineers' Club of Seattle** held a joint meeting Mar. 21 at which George F. Nicholson, chief engineer of the port of Seattle, presented a paper on "Port of Seattle Engineering Problems," illustrated with motion pictures of port operation along the Atlantic coast.

The Engineers' Club of Seattle was addressed Mar. 20 by Lloyd Robey on "The Chuquicamato Mine of Chile," of which he is assistant superintendent.

The Indiana Sanitary and Water Supply Asociation will hold its annual meeting in Indianapolis Apr. 9-10.

The American Welding Society, the formation of which was noted in *Engineering News-Record* of Mar. 13, p. 545, held its first meeting Mar. 28 in New York City. The constitution and bylaws recommended by the organization committee were adopted, and the following officers were elected: President, C. A. Adams, Cambridge, Mass.; secretary, H. C. Forbes, 33 W. 39th St., New York City.

The Cornell Society of Civil Engineers will hold its spring meeting Apr. 14, at the United Engineering Societies' Building, New York City. Prof. C. R. Mann will speak on engineering education, and the proposed combination of Sibley College and the College of Civil Engineering will be discussed. It is expected that this will be a joint meeting of the recently organized association of Sibley men and the Cornell Society of Civil Engineers.

The Engineers' Club of Trenton, N. J., was addressed Mar. 27 by R. J. Wig, chief of the concrete ship section, Emergency Fleet Corporation, who presented a paper on "The Present Status of the Concrete Ship," illustrated with slides.

The Rochester Society of Technical Draftsmen was addressed Mar. 27 by Frank C. Taylor of the Rochester Railway & Light Co., who spoke on "Illumination."

The Oregon Society of Engineers held a smoker in Portland Mar. 21, at which various members and guests spoke on the subject of the compensation of engineers, although no prepared addresses had been planned. There was a general discussion of the advisability of organizing engineers for the purpose of obtaining higher rates of pay.

The Oregon Association of Members of the American Society of Civil Engineers held a meeting in Portland Mar. 20 at which Robert A. Cummins, consulting engineer and contractor of Pittsburgh, member of the Committee on Development, spoke on the work of the committee. Mr. Cummins was in Portland serving with a board of four other engineers, studying the subsidence of the Portland municipal grain elevator on the Willamette River.

The Rochester, N. Y., Engineering Society will hold its regular monthly meeting Apr. 11. George Halcott Chadwick, assistant professor of geology, University of Rochester, spoke on "What is Under Rochester" at the weekly luncheon Mar. 31.

The Pittsburgh Chapter of the American Association of Engineers will be addressed Apr. 17 by C. E. Drayer, national secretary. The chapter has taken headquarters in the Fulton Building; they are in charge of F. E. N. Thatcher, secretary.

The Civil Engineers' Club of the Carnegie Institute of Technology, Pittsburgh, was recently addressed by C. K. Harvey, of the Koppers Co., who spoke on "Civil Engineering Work in Byproduct Coke Plants."

PERSONAL NOTES

CAPT. LITTELL SNIVELY, Engineers, U. S. A., has received his discharge from the service and has become mine engineer, Guanajuato Consolidated Mining & Milling Co., Guanajuato, Mexico.

WILLIAM C. HALE, assistant chief engineer, Rust Engineering Co., Pittsburgh, has resigned to become chief engineer of the Andrews Engineering Co., also of Pittsburgh.

ALBERT LADD COLBY, consulting engineer and iron and steel metallurgist, South Bethlehem, Penn., has been appointed representative of the American Society for Testing Materials on the Engineering Council.

CAPT. ELWOOD AVERY, Construction Division, U. S. A., has received his discharge from the service and has become associated with G. W. Ensign, Inc., engineers and contractors, Harrisburg, Penn., as chief engineer.

E. L. MARTIN, engineer maintenance of way, Missouri, Kansas & Texas R.R. and associated railroads, has been appointed chief engineer with jurisdiction over the Missouri, Kansas and Texas Lines of Texas and the Missouri, Kansas & Texas R.R. He was born in 1879 and received his education at the Agricultural and Mechanical College of Texas. He entered the service of the Southern Pacific Lines in 1899, becoming assistant engineer three years later. He afterward became connected with the Kansas City Southern and later became division engineer for the Gulf Coast & Santa Fé Railway in Texas. Afterward he served as assistant superintendent for the Southern Pacific at Lafayette, La. In 1913 he became division engineer for the Missouri, Kansas & Texas, and was appointed engineer maintenance of way in 1917.

CAPT. A. L. MULLERGREN, Construction Division, U. S. A., having been discharged from the service, has returned to his work as secretary and treasurer of the Benham Engineering Co., consulting engineers, Oklahoma City, Okla. Captain Mullergren was officer in charge of steam heating and assistant to the constructing quartermaster at Camp Funston, Kansas.

C. H. PURCELL has been appointed bridge engineer for the Oregon State Highway Commission, assuming office Apr. 1. Several years ago Mr. Purcell served as bridge engineer for the commission, when H. L. Bowlby was its chief engineer. Later he was bridge engineer for two years in the Multnomah County engineer's office, after which he returned to the Highway Commission as bridge engineer and assistant chief engineer. More recently he has been attached to the Portland office of the Department of Roads and Rural Engineering.

LIEUT. HARRY B. FRIEDMAN, Air Service, U. S. A., who received his discharge in January and entered the service of the W. E. Wood Co., general contractors, Detroit, as engineer and representative in Fort Worth, Tex., has resigned to enter into a partnership with Butcher & Sweeney, general contractors, Fort Worth.

LIEUT. C. E. PRETZ, Engineers, U. S. A., has received his discharge from the service and resumed his work with the Public Service Commission, with headquarters in New York City.

CAPT. H. RAY KINGSLEY, Engineers, U. S. A., who received his discharge from the service in February, is now engaged in his former work as building engineer for the insular government, Bureau of Public Works, Manila, P. I. In 1916 he went to France on leave from the insular service and enlisted in the American Ambulance Corps of the French Army, where he served for three months, afterward returning to the United States on his way to the Philippines, where he was commissioned in the Engineers in October, 1917.

MAJ. WALTER B. ELCOCK, U. S. A., has been discharged from the service and has returned to his work as manager of the Atlanta office of the Portland Cement Association.

LIEUT. COL. W. M. DENMAN, Engineers, U. S. A., has been discharged from the Army in France and has become a member of a company known as "Société d'Importations Américaines," with office at 57 Rue de

l'Université, Paris-7e. The new organization, as its name indicates, will engage in importing American products into France. Colonel Denman's home is in Springfield, Mass.

MAJ. JAMES H. BRACE, 22nd Engineers, a light-railway regiment who recently returned from France, has been discharged from the Army and has resumed his work as vice-president of Fraser, Brace & Co., contractors, New York City.

LEWIS R. ASH of Harrington, Howard & Ash, consulting engineers, Kansas City, has tendered his resignation as city manager of Wichita, Kan.

GEORGE WORTH, formerly associated with the Sager Lock Co., North Chicago, has been appointed chief engineer of the city water works of Waukegan, Ill.

ADOLPH F. MEYER, chief engineer and general superintendent, Minnesota & Ontario Paper Co., International Falls, Minn., has resigned and will resume private practice, specializing in hydraulic, structural and paper-mill engineering, with headquarters in St. Paul or Minneapolis.

MAJ. ERNEST MCCULLOUGH, of the Chemical Warfare Service, formerly consulting engineer of Chicago, Ill., has been made lieutenant colonel. He is still in France.

COL. FRANCIS F. LONGLEY, Engineers, American Expeditionary Forces, in charge of water-supply in the advance and rear sections, has been detailed to go to London and take charge of Army educational work at English universities. Before entering the Army he was a member of the firm of Hazen, Whipple & Fuller, New York City.

MAJ. J. C. SMITH, American Expeditionary Forces, who recently returned to this country, has received his discharge and has become office engineer, Northwestern Region, United States Railroad Administration, with headquarters in Chicago. He was formerly in the service of the Spokane, Portland & Seattle Railroad.

W. E. BECKER and C. R. SMYTH have become associated under the firm name of Becker & Smyth, contracting engineers, Chicago.

MAJ. G. T. LEMMON, Engineers, U. S. A., who received his discharge from the service in January, has become resident engineer of the Virginia State Highway Commission, with headquarters at Suffield. He entered the service as a first lieutenant of engineers in July, 1917.

CHARLES WUEST, JR., formerly engineer of roads, United States Nitrate Plant No. 4, has been appointed office engineer, Division of Highways, Illinois Department of Public Works and Buildings, with headquarters in Springfield.

MAJ. CARLISLE MASON, American Expeditionary Forces, having returned from France and received his discharge from the service, will resume the practice of general consulting engineering, with main office at 207 Broadway, New York City, and branch office at 81 Rue St. Lazare, Paris, France.

A. E. TRIPLEGG, district engineer of the Missouri, Kansas & Texas R. R. of Texas, has been appointed engineer maintenance of way, with headquarters at Dallas.

H. R. CARTER, state highway engineer of Arkansas, has resigned to engage in private practice.

BRIG. GEN. B. P. DISQUE, chief of the Spruce Production Division, U. S. A., has been appointed to the chairmanship of the export and import branch of the American International Corporation, New York City, having received his discharge from the service Mar. 15. He is succeeded as president of the Spruce Production Corporation and commander of the first division by his former chief of staff, Lieut. Col. C. P. Stearns.

CAPT. M. Z. BAIR, Construction Division, U. S. A., has resumed his duties in the division of sanitary engineering, Ohio State Department of Health, having received his discharge from the Army.

CHARLES H. HURD, consulting engineer, Indianapolis, has resigned from the Board of Sanitary Commissioners and will devote his entire time to private practice. Lucius B. Swift, member of the bar of Indiana, has been appointed a member of the commission.

CAPT. ALVAH G. HUSTED, Sanitary Corps, U. S. A., will resume his work with the Indianapolis Sanitary Commission, having left the Army.

CAPT. S. M. SMITH, Engineers, U. S. A., recently returned from overseas, has received his discharge from the service and has returned to the office of the chief engineer, Wabash Ry., as principal assistant engineer. In France Captain Smith was engaged in the development of the canvas portable-type foot bridge, which met with success in the battle of the Meuse during the week previous to the armistice.

F. RAYMOND KEYS has left the service of the Bureau of Yards and Docks, U. S. N., with which he was associated during the war, and has become connected with the Nugent Construction Co., New York City.

CAPT. JOHN W. TOYNE, Utilities Officer, Camps Chickamauga Park and Fort Oglethorpe, Georgia, has received his discharge from the service and will resume the private practice of engineering at South Bend, Ind.

D. J. CAMERON, who recently received his discharge from the Engineers, U. S. A., has been appointed to take charge of the northern New Jersey territory of the Fireproof Products Co., Inc., New York City, with headquarters in Newark.

H. H. JOHNTZ, division engineer, Missouri, Kansas & Texas R.R. at Parsons, Kan., has been appointed engineer maintenance of way of the Missouri, Kansas & Texas R.R. and the Oklahoma Belt, with headquarters at Parsons.

OSCAR F. LACKEY and LYMAN L. LIVINGSTON have become associated under the firm name of Lackey and Livingston, consulting engineers, 17 Battery Place, New York City.

W. H. VANCE, engineer maintenance of way, St. Louis-Southwestern and Louisiana & Arkansas Rys., has been appointed engineer maintenance of way, St. Louis, Southwestern and Associated Lines, including the St. Louis Southwestern of Texas, the Eastern Texas, Dallas Terminal & Union Depot, and the Southern Illinois and Missouri Bridge R.R., with headquarters at Tyler, Tex.

OBITUARY

MAJ. JAMES ALFRED ROOSEVELT, U. S. A., previously general superintendent of the Third Avenue R.R., New York City, died Mar. 26 on the naval transport Great Northern, on its way to the United States. He was born in 1885 and was graduated from Harvard University in 1905, soon afterward forming the engineering firm of Roosevelt & Thompson, New York City. In 1907 he became general superintendent of the Third Avenue R.R. Four years later he was appointed to direct the system of street-railway and interurban lines of the British Columbia Co., with headquarters in Vancouver, B. C. He received the commission of captain early in 1917 and was assigned to the 308th Infantry. He was in much of the heavy fighting with the 77th Division.

CAPT. STUART THOMSON, Ordnance Dept., U. S. A., died in Brookline, Mass., Mar. 23. He was graduated from Harvard University in 1908 and from the Massachusetts Institute of Technology in 1909. He had recently returned from Washington, where he had been engaged in the production of aircraft armament for the past year and a half.

CAPT. ARLY L. HEDRICK, Engineers, American Expeditionary Forces, died recently in Brest, France. He received his education at Yale University and the University of Wisconsin.

AUGUSTUS W. NEWELL, railway and mining engineer, died at his home in Bradford, Penn., Mar. 25. He was born in 1832 and did his first work on the Brookline reservoir and later was employed by the Boston & Maine R.R. He was also engaged in the location of the Charles River R.R. and the "Air Line" of eastern Massachusetts. In 1856 he became associated with the Buffalo, Bradford & Pittsburgh R.R., becoming a director of the line in 1863. After that time he engaged in mining operations and assisted in the development of the Bradford oil fields.

Tractor Output for 1918-19

A total of 132,697 tractors was manufactured in 1918, and it is estimated that 314,936 will be manufactured in 1919, according to a report of the United States Department of Agriculture based upon inquiry made among manufacturers. The figures for 1919 are of course merely estimates, and represent the aggregate of the estimates submitted by the tractor manufacturers in January and February of this year.

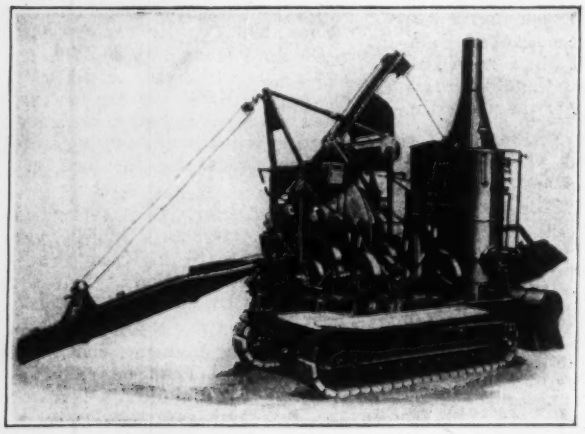
Construction Machinery Exports

An indication of the extent of American export trade in construction machinery is contained in the reports of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, Washington, D. C., for January. Two of the items are: Pumps and pumping machinery, $572,445; excavating machinery, $26,627.

New Paving Mixer Propelled by Multiple-Tread Apparatus

A concrete paving mixer with track-laying propulsion is shown in the accompanying illustration. It is intended to obviate the necessity of using planking over subgrade too soft to bear the load of the ordinary wheel-propelled outfit. The machine is also equipped with a batch-timing device which locks the discharge trough, so that each batch must be mixed until any fixed time previously determined and set in the timer has been completed.

The treads are 9 ft. long and 14 in. wide, which, with the 18,000 lb. weight carried, gives a ground pressure per square inch less than that of the average walking man. The treads are driven independently of one another through friction clutches, which permits the turning of the machine in its own length.



PAVING MIXER EQUIPPED WITH MULTIPLE-TREAD PROPULSION

Other advantages claimed are: A large saving in cost, due to the elimination of planking and the delays incident to its use; noninjury to the finished subgrade, and ability to operate where machines of the old type cannot go.

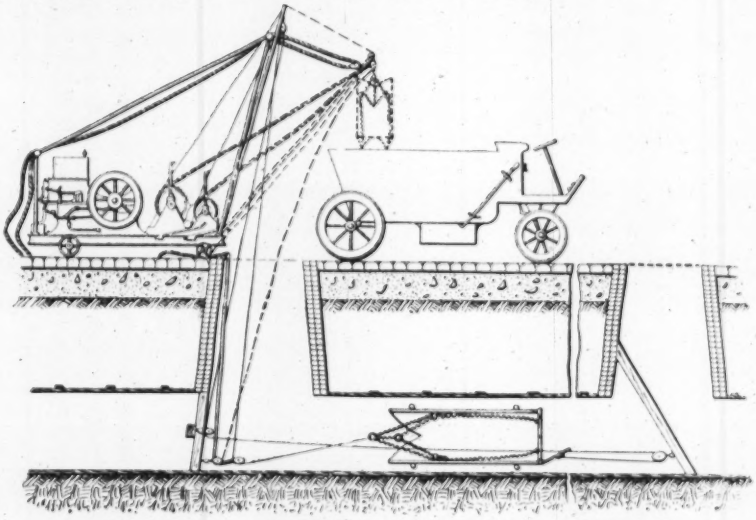
The machine illustrated is manufactured by the Foote Co., Inc., Nunda, N. Y., and these treads are put on both sizes of its paving mixers. Application has been made for a copyright on the trade name "Multi-Foote" for the tread.

Sewer Cleaner is Operated by Crew Above Ground

Elimination of the necessity for a sewer-cleaning crew to work in the water and poison gas of the sewer chamber is the purpose of a device invented and patented by P. J. Healey, contractor, of 30 Church St., New York City. Cables and pulleys are arranged so that a small pipe derrick with a gasoline engine may drag a digging bucket back and forth through the sewer and then hoist it to the street level, while the whole crew remains above ground.

It is necessary to place a timber in each manhole to hold the pulleys. The cables pass down the near manhole, and change direction on blocks, and are fastened to either end of the bucket, the line to the bottom of the digging bucket passing around the block in the far manhole. To make it possible to lift the bucket from the sewer, the direct line block at the near manhole is attached to the end of a rope passing through another block which is secured to the timber. When the bucket is pulled up, the first block comes up with it, pulling the rope through the second block. By pulling in and fastening the rope as the bucket is lowered, the outfit is again prepared for digging.

The bucket has a double shovel-shaped nose and a two-leaf dump bottom, as illustrated. In order to facilitate travel through the sewer, small casters have been placed on its sides. Digging is a scraping process, the bucket being dragged back and forth, loosening and collecting the spoil, until full. It is stated that members of the crew are required to work in the sewers only when placing the timbers which hold the pulleys.



OPERATION OF IMPROVED SEWER-CLEANING MACHINE

BUSINESS NOTES

The Berger Mfg. Co., sheet steel products, New York City, announces that it has moved its office from 154 Eleventh Ave. to 516-524 West 25th St., New York City.

The New Way Motor Co., Lansing, Mich., manufacturer of air-cooled gas engines, announces the appointment of Harry J. Sproat as secretary and factory manager.

The Flower-Stephens Mfg. Co., Detroit, manufacturing valves and hydrants under the trade name "Michigan," is now to be known as the Flower Valve Manufacturing Co.

The Eastern branch of the Independent Pneumatic Tool Co. in New York City, has been moved from 170 Broadway to 1463 Broadway. The company's pneumatic and electric tools and gasoline engines are sold under the trade name "Thor."

The excavation machinery manufactured by the Pawling & Harnischfeger Co. is to be handled by the following newly appointed agents: the W. E. Austin Machinery Co., Atlanta, Ga.; the Henry H. Meyer Co., Baltimore, Md.; Edlen & Co., Philadelphia, Penn.; Charles J. McCarty, Boston, Mass.; the W. W. Williams Co., Columbus, Ohio; the W. B. Louer Co., Chicago,

Ill.; the H. W. Moore Co., Denver, Colo.; W. H. Zeigler, Minneapolis, Minn., and Gaston, Williams & Wigmore, Inc., New York City. The last named firm is an exporting agent.

H. A. Frank, managing director of the Nova Scotia Shipbuilding & Transportation Co., Ltd., Liverpool, N. S., has also recently been made managing director of the Mirimachi Construction Co., Ltd. The new company has taken over the assets of the International Shipbuilding Co., Ltd., Newcastle, N. B., consisting of yard, plant, machinery, stock of material and a vessel framed on the stocks. Operations will begin immediately for the completion of this boat, and the same company will also construct a small vessel of about 150 tons net register.

The Poston Paving Brick Co., of Crawfordsville, Ind., one plant, and the Burton-Townsend Co., of Zanesville, Ohio, two plants at Zanesville and one plant at Ashtabula, Ohio, have become licensees of the Dunn Wire-Cut Lug Brick Co., of Conneaut, Ohio, and will engage in the manufacture of wire-cut lug paving brick.

The Carson Petroleum Co., 208 So. La Salle St., Chicago, Ill., announces that George Fuchs, formerly of the Texas Co., asphalt sales department, has been appointed Southern representative of the asphalt and road-oil sales department of the Carson Co., with headquarters at Tampa, Fla.

The W. A. Jones Foundry & Machine Co., of Chicago, manufacturer of power-transmission apparatus, special foundry and machine work, together with the Jones spur gear speed reducer, has opened an Eastern office at 30 Church St., New York. Lemuel C. Biglow, formerly with the Morse Chain Co., of Ithaca, N. Y., is in charge of the New York office.

The Epping-Carpenter Pump Co. announces the appointment of F. S. Healey as manager of sales, in addition to his former office of chief engineer. He will replace F. F. Woods, who is now located in New York as Eastern sales manager. Other appointments are those of Albert A. Scheuch of the sales department as assistant sales manager, and Paul D. Goodman, formerly of the McClary-Jemison Machinery Co., of Birmingham, Ala., to the sales department.

The United Gas Improvement Co., Philadelphia, Penn., announces the formation of another department, to be known as the U. G. I. Contracting Co. The new organization, besides handling the construction and sale of water-gas apparatus, vertical retorts, etc., will design and erect power plants and will maintain a special road division competent to construct and maintain roads. Paul Thompson, one of the vice-presidents of the parent company, will have charge of the new organization. The other officers are J. A. P. Criffield, vice-president, for engineering; D. J. Collins, vice-president, for sales.

Construction Costs Stabilizing—Material and Labor Markets

Only General Decline Was in Steel—Labor Conditions Shown in Many Sections—Stagnation in the Building Trades

By Alden W. Welch

Common Labor

The impression seems to be quite general that there is a heavy surplus of common labor. It is true that in certain sections — particularly on the Pacific Coast — labor is plentiful, but this condition does not prevail throughout the country. It might be expected that at a great port of debarkation, such as New York City, common labor would be a drug on the market. Yet the reverse is the case, according to the Building Trades Employers' Association of this city. In spite of the homecoming soldiers, common labor is not over-plentiful and the wages are high. Pick and shovel men are paid $3.50 to $4 per eight-hour day; semi-skilled laborers, $4 to $4.50.

On the Pacific Coast

The unstable condition created by the Government in acceding to the shipyard laborers' demand for higher wages is noticeable on the Coast, as elsewhere. The rate of shipyards under the Macy award is $4.16 per eight-hour day; while at Government-owned yards $4.64 is paid. This unbalance exists in San Francisco, at the Puget Sound Navy Yard at Bremerton, Wash., and in the privately owned plants in the same district; and at San Pedro, in southern California.

For unorganized or nonunion labor the wages paid all along the Western coast are $3.50 to $4 a day. It is reported that the City of Oakland has just advertised a civil-service examination for laborers, offering wages of $3.50 per day.

Unskilled labor out of employment in the larger cities of California is estimated at from 20,000 to 25,000.

In Portland, Ore., the unemployed are estimated at 10,000 to 12,000; in Seattle and Tacoma, Wash., at about the same figure. Before the armistice was signed it was almost impossible to obtain labor, the minimum wage being $4. There are several reasons that account for the present abundance of labor. There has been the usual migration into California from nearby sections where there is little winter work. The cessation of war activities has, of course, thrown many men out of work. The copper mines have either closed down completely or have curtailed production greatly. The same situation obtains in the lumbering sections. Owing to the high cost of construction, very little new work is starting. The public utilities are doing only maintenance work. Finally, but not least, the soldiers are returning.

In St. Paul the largest employer of labor, at the present time, is the Armour plant at South St. Paul, where 42½c. per hour of a ten-hour day is paid. Paving contractors, who expect to bid on a large amount of city work, seem to think that labor may drop to 37½c. about July, but that this rate will mark the minimum for 1919. Contractors in the Northwest do not anticipate a surplus of labor after the season opens. There is a difference of opinion as to the number of unemployed at the present time. Building contractors, who are not doing much work, say that there are 15,000 men in St. Paul and Minneapolis. Busy contractors deny this. As an indication that small municipalities will go ahead with their paving programs, one contractor points out that Tracy, Minn., has just let a contract for concrete pavements at $1.87 per square yard, against last year's contract price of $1.57 for work under the same specifications.

In St. Louis there is a surplus of common labor. On sewer work the rate has fallen to 35c. an hour. On brick work the wages paid are 27c. to 30c. On grading and concreting the minimum is 25c. to 27c. These are the rates paid by general contractors. Union labor in the building trades has just received an advance, but there is practically no building work going on at present.

In Birmingham, Ala., and vicinity there is a surplus of common labor, according to local employers, owing to the temporary closing of the large furnaces and the curtailment of production by some of the coal mines. Common labor is paid from $2.50 to $3 a day. The Board of Revenue of Jefferson County is paying $2.50, and is obtaining at this figure all the labor required for the work of the county. Contractors are paying, in a number of instances, $3, and in some cases slightly more. It is reported that there is a considerably greater surplus of skilled labor than of common; but the contrary is asserted by several contractors.

The City of Dallas pays labor $2.50 to $2.80. Contractors pay building laborers 30c. an hour; hod-carriers, 35c. and 40c.; sewer and paving men, $2.50, $2.80 and $3; for eight-hour days in all cases.

In Pittsburgh hod-carriers, mortar mixers and skilled laborers are paid, under the union scale, 60c. per hour, $4.80 per day, $26.40 per week of 44 hours. Common laborers receive 45c. per hour, $4.05 per nine-hour day, $25.00 per week of 54 hours. These rates hold until further notice, as there is no expiration agreement, and there are therefore no arbitration rules.

In Kansas City labor is plentiful. It is reported that many returned soldiers were employed as common laborers, but shortly were dismissed on request of the unions. Several soldiers applied for admission into the unions, but were informed that for the present no new members were being accepted. No nonunion labor is employed in the building trades in this city. On street paving, on the other hand, only nonunion labor is used. The schedule paid on brick, concrete or stone-block paving is as follows:

Crafts	1919
UNSKILLED	
Rock wheelbarrow men	$0.40
Shovelers	.40
SKILLED	
Concrete graders	$0.55
Brick setters	.65
Stone setters	.75
Roller engineers	.75
IN ASPHALT PAVING—UNSKILLED	
Rock wheelbarrow men	.40
Shovelers	.40
Clean-up men and roustabouts	.40
SKILLED	
Smoothers	.45
Tampers	.45
Concrete graders	.55
Roller engineers	.75

SUMMARY

The foregoing can be best summarized by a table showing conditions—rates, hours in a working day, availability and classes of common labor—in the important centers of the country. Such a tabulation follows:

COMMON LABOR TODAY

(In 3rd column, P means labor is plentiful, S means scarce)

City	Rate per 8-Hour Day	Situation	
Birmingham	$2.50	S	
Boston	3.20	P	
Dallas	2.40		Buildings
Dallas	2.80-3.20		Hod carriers
Dallas	2.50-2.80		City
Dallas	2.50-3.00		Sewers (and paving)
Kansas City	4.20		Buildings
Kansas City	3.20		Nonunion
New Orleans	2.40	P	
New York	3.50-4	S	Pick and shovel
New York	4.00-4.50	S	Semi-skilled
Pittsburgh	4.05 (9 hour)		Common
Pittsburgh	4.80		Hod carriers
San Francisco	4.16	P	Shipyards—Macy award
San Francisco	4.64	P	Shipyards—government owned
San Francisco	3.50-4	P	Nonunion
St. Louis	3.50 (10 hour)	P	Sewer
St. Louis	2.50-2.70 (10 hour)	P	Concrete
St. Louis	2.70-3 (10 hour)	P	Brick
St. Paul	4.50 (10 hour)	P	

Construction Materials

The general price tendency is downward. About half of the construction materials have declined, the other 50% remaining firm. Of course, the principal movement was in iron and steel, as follows: Pig iron, basic, to $25.75 per ton, reduction $4.25; 4-in. billets, to $38.50, reduction $5; sheet bars, to $42, reduction $5; slabs, $42, reduction $5; skelp, merchant bars, sheared plates and structural base, No. 28 black sheets, No. 10 blue annealed, No. 28 galvanized sheets, all reduced $7 per net ton. As for rails, both standard bessemer and openhearth were lowered $10 per net ton, to $45 and $47, respectively. Steel and iron pipe were lowered 3½ points. These new prices are not arbitrary prices fixed by the Government, but are prices suggested by the Government and met by the manufacturers. The Government has committed itself to make purchases at these prices and has recommended the same course to general consumers. Every indication points toward a continuation of the new schedule. The decrease was not the result of panic. Its moderateness proves that it was arrived at coldly. Many buyers expected a more substantial reduction. That the Government accepts this revised schedule and agrees to do business under it indicates that the schedule is the minimum that can be made under present conditions.

All precedent is against a sharp decline this year. Except for steel products, sewer pipe, lumber in certain sections, and dynamite, the market is practically as it was a month ago. Prices will continue to fall, but not appreciably this season. Whoever has a project that should be got underway this year may call for bids and award it to the lowest bidder, feeling practically certain that he is not only getting it done at the best price obtainable this season, but that he is helping to turn the wheels of industry at large.

WHAT THE COUNTRY SAYS

Minneapolis has just let the following contract for paving materials for 1919: 100,000 bbl. of cement at $2.30 (without bags) f.o.b. city, to P. G. Speaks and to the Landers-Morrison-Christenson Co., local concerns; 500,000 sq.yd. of 3½-in. yellow-pine creosote blocks at $2.07 per square yard f.o.b. city, to the Central Creosoting Co.; 100,000 sq.yd. of brick pavers at $1.45 per square yard, to the Streator Clay Mfg. Co. The present price of cement in carload lots, is $2.40 net in the Twin Cities. Wood blocks are quoted at $2.20 per square yard.

Probably the liveliest class of construction throughout the country is street and road work. It is, therefore, interesting to note the following sharp decline in the price of wood blocks, just reported in St. Louis, as shown in the table at the top of the next column.

This reduction is probably due to exceptionally keen competition. It is allaged that bidding in St. Louis by manufacturers not of that city reduced the price of wood block in a recent letting to less than the figures given in the table.

DECLINE IN PRICES OF WOOD BLOCKS, ST. LOUIS

Size	Per Square Yard Mar. 1	Apr. 1	Decrease
3½-in.	$2.45	$2.19	$0.26
4 in.	2.60	2.50	.10
3½-in., Minneapolis specifications	2.40	1.94	.46
4 in., Minneapolis specifications	2.55	2.25	.30

Stanolind asphalt in St. Louis has declined $3 per ton (in bulk), $3.40 per ton (in packages), owing, apparently, to heavy stocks. The same is true of Texaco, the price of which is slightly above that of Stanolind. Common (salmon) brick has dropped from $12 per 1000 to $10, while paving brick lowered from $28 to $26. Brick manufacturers assert that these decreases were made to stimulate construction, and that they will incur a loss unless a large volume of business ensues. The reduction in the price of sewer pipe is apparently on the same basis. It is stated on authority that the reduction most desired in St. Louis would be in cement.

In Kansas City there is practically no change since last month. The stated belief is that prices, except of lumber, may decrease in harmony with the drop in steel. The immense campaign now on, however, may create a demand for materials that will hold up the present prices for a time. Considerable public work is underway and much more scheduled. The largest job is the 23rd St. viaduct, let to the A. S. Hecker Co., Cleveland, for $716,000, which includes a $50,000 profit fee. A $1,500,000 sewer contract and $900,000 worth of dikes for flood protection are to be let soon.

Everybody is anxious for building operations to get underway. From Chicago comes the encouraging report as to the building permits issued in the last three weeks of March shown in the accompanying table.

ANALYSIS OF BUILDING PERMITS, CHICAGO, IN LAST THREE WEEKS OF MARCH, THIS YEAR

Week Ending	No. of Permits	Residences	Stores	Factory	Storage	Miscellaneous Buildings	Total
Mar. 15	49	73	4	4	2	4	87
Mar. 22	58	80	1	3	5	4	93
Mar. 29	..	124	6	5	7	7	148

	No. Over $100,000	No. Over $50,000	No. Over $5,000	No. Less Than $5,000	Total Amount
Mar. 15	None	2	19	28	$521,000
Mar. 22	2	3	19	34	1,370,500
Mar. 29	3	3	42	40	1,437,000

While on the subject of building permits it may be worth while to give a comparison of values issued in February, 1919, and the preceding year in five of the larger cities of the Canadian province of Quebec, as indicating that building work is increasing outside the United States as well as inside our country.

City	February, 1919	February, 1918
Montreal	$151,740	$77,045
Quebec	53,630	25,147
Sherbrooke	90,000	.....
Three Rivers	24,800	17,000
Westmount	.....	15,500
Total	$320,170	$134,692